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The Look Box

Demand and Expenses

APPARENTLY last year, the industry's "guesstimators," practically all of them, went wrong. Carefully prepared analysis of motor-fuel demand, widely published, promised the refining industry a 5 to 7 percent increase in motor-fuel demand during 1938. Heretofore the industry's economists in their annual forecasts had been right, but the depression of 1938 assumed more serious proportions than was anticipated by most prognosticators. It appears now that domestic motor fuel demand for 1938 may be about 1 percent less than in 1937—and the demand for all oils is coasting along at around 1 percent under last year. It is still a whale of a lot of oil.

Overindulgence in crude oil processing by the refiners this year finds the situation as regards stocks of gasoline and stocks of fuel oils not so good. The summer season behind us, the large demand months, did not absorb sufficient of the industry's stocks. The fuel-oil demand last year was overestimated, hence large stocks of that commodity have accumulated. The coming winter's operations must be handled carefully to avoid softer prices for refined products. Everyone apparently expects 1939 to be a better year for the industry. It is certainly hoped that such will be the case.

However, the refining industry, spurred on by the ever present need for improving the quality of its products and the more urgent need for reducing its processing costs, is preparing to spend many millions of dollars in capital investment during the coming year. One estimate is $170,000,000, another is $200,000,000, while a third is $250,000,000, any of which represent a lot of money.

High octane rating motor fuels can not be made with obsolete equipment. The type of motor fuels demanded now can not be produced profitably on any but the most modern, efficient, carefully operated, and constantly maintained processing facilities. Octane ratings of 100 can not be produced for air travel except with the best in polymerization, hydrogenation and their corallary processes and in combination with modern, efficient cracking plants. Lubricants of present day type that are in most demand can not be produced in the good old-fashioned way.

Profitable refinery operations hinge upon the utilization of the more efficient and recently perfected processes which give greater yields of higher quality petroleum products at lower operating costs.

The expected increase in motor fuel demand must come and with it will continue the demand for better fuels, and the demand will in all likelihood not be accompanied by any marked increase

in prices. Thus the industry remains confronted as ever, with the problem of rehabilitation and improvement of its processing facilities to provide constantly improving quality at improved operating costs. Obsolete equipment has no place in such a picture.

Retrograde Condensation

PLANTS of a new type with gasoline production as but one of their functions are coming to various localities in the petroleum industry. These plants, be they called pressure maintenance, gas recycling, repressuring systems, or the more common "distillate plants" will produce additional volumes of gasoline over longer periods while they are doing their job of maintaining reservoir pressures. They simply combine the present type of plants used for reinjection of gas into oil bearing sands, plus facilities for removing the distillates produced with the gas, which in turn may be fractionated or stabilized at the plant.

An ever-increasing majority of engineers believe that gas in solution in reservoir oil should not be permitted to escape until the oil has entered the tubing leading to the surface. Loss of fluidity of reservoir oil by reduction of the viscosity through the liberation of gas in solution is an additional impediment on recovery imposed by lowering the reservoir pressure. Production research laboratories are investigating every phase of liquid flow through porous media in seeking more efficient oil-recovery methods.

With the recent trend toward deeper drilling and the resulting discovery of a number of producing zones below 7,000 feet, engineers have found themselves facing new problems, not the least of which is the high pressure encountered at the new depths. With production at higher pressures has also come more general recognition that a gas reservoir may contain distillate or high gravity oil in a vapor or gaseous state, which gaseous distillate condenses upon the lowering of the reservoir pressures beyond a critical point. In other words, instead of becoming more gaseous with lowered pressure as might reasonably be expected, part of the vapor enters the liquid state.

This is retrograde condensation, a subject of much present investigation, for there is little doubt but that control of this force will have much to do with high recovery from deeper structures. The so-called "distillate" fields are now numerous in various parts of Texas and in North and South Louisiana and further exploitation in the production branch will no doubt locate many of them in other states. State legislatures may force the issue of plant installation because of present tendencies toward gas wastage to secure some of the light distillates.

Some engineers who have studied the problem of production from high-pressure-distillate wells believe that much of the high-gravity crude or distillate will be left unrecovered on the reservoir sand grains through condensation as the reservoir pressure drops with production. In light of recent knowledge of the action of high-pressure distillates, this theory is tenable. The one way to avoid such loss, it is claimed, is to maintain the original pressures supporting the reservoir equilibrium. This can be accomplished by removing the gaseous contents of the reservoir, then extract the distillate or heavier hydrocarbons, and then return the lean gas to the top of the structural accumulation as long as the operation is profitable. Thus the type of plants to be required are of the dual gasoline extraction and compression system, accompanied by stage separation and perhaps distillation or stabilization facilities.

Research laboratories have been studying retrograde condensation and its effects. A sample of reservoir oil and saturated reservoir gas may be put in the same bomb at atmospheric pressure. When the pressure is increased by pumping mercury into the same container, liquid is condensed out of the gas and the liquid mass increases with increasing pressure. To this point the action follows recognized basic physical laws. However, the retrograde phenomenon of condensation soon becomes apparent.

When the pressure reaches a critical point the liquid mass begins to decrease, and certain portions of the previously condensed liquid re-enters the gas above it. This decreasing of the fluid mass continues until at a very high pressure, say of 5000 pounds or more, the liquid and gas have about the same density and there is little or no actual fluid left in the testing vessel.

Laboratory experiment has not been carried far enough along at this time to allow definite conclusions to be drawn. However, there are some interesting assumptions allowable.

The producing of condensate by the application of pressure is an action first producing liquid from the heaviest ends contained in the sample. As the pressure increases the next heaviest hydrocarbons enter the liquid phase, consecutively, until only the extremely light gases remain in vapor state at the high pressures. It is this process which is reversed in retrograde condensation.

It is reasonable to assume from this that the point at which a hydrocarbon liquid is driven into the gaseous state by pressure is variable, rather than critical, and is dependent upon the constituents composing the sample.

(*Continued on page 55*)

DEHYDROGENATION OF THE Lower Paraffins Over Activated Alumina Catalysts

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INCREASING demands for the lower olefins as base materials for synthetic gasoline and chemical products have led to the investigation of catalytic dehydrogenation processes for their production from the lower paraffins. This paper gives results of experiments with activated alumina, alone and combined with chromium oxide, which has proved to be a selective catalyst for dehydrogenation. This type of catalyst is stable at temperatures favorable to the dehydrogenation from the standpoint of equilibrium. Although its catalytic activity decreases with time, it can be repeatedly regenerated.

THE lower-molecular-weight paraffins and olefins that form in large quantity during the cracking operation were at first considered by the petroleum industry as undesirable by-products, which could be used at best as fuel. However, with the increasing development of processes for the manufacture of synthetic chemical and gasoline products from the lower olefins, the situation has gradually changed so that the time is not far distant when a shortage of certain of these olefins may be expected.

In anticipation of such a shortage, extensive work has been conducted in these laboratories over a number of years on processes for increasing the supply of olefins. The present paper deals with one of these processes, the catalytic dehydrogenation of propane, normal butane, and isobutane.

THERMAL VS. CATALYTIC REACTION

In the pyrolysis of hydrocarbons the splitting of the carbon-to-carbon bond predominates and little control is obtained of the final reaction product. Thus when propane, normal butane or isobutane is subjected to pyrolysis, considerable quantities of lower paraffins and olefins, as well as carbon and hydrogen, are produced, and dehydrogenation to an olefin of the same number of carbon atoms takes place to an unsatisfactory degree.

Equilibrium data show that olefin formation by dehydrogenation should be extensive at temperatures where breaking of carbon-to-carbon bonds occurs only to a small degree; theoretical conversions, calculated from previously determined[4,9] equilibrium values are shown graphically in Figure 1. Thus with a suitable catalyst it would be possible to selectively accelerate the dehydrogenation reaction at the expense of the other pyrolytic reactions.

In selecting a catalyst, cognizance must be taken of the thermal stability of the hydrocarbon, for this will affect the allowable temperature of operation. Of the three hydrocarbons studied, propane is the most stable, followed by isobutane and normal butane.[3]

EXPERIMENTAL PROCEDURE

The experimental work was carried out with propane, normal butane, and isobutane of 95 to 98 percent purity, prepared by fractionation from petroleum gases. These hydrocarbons were passed through a drying tube containing calcium chloride and then through a quartz reaction tube containing the catalyst under examination; the reaction tube was heated in either a gas or an electric furnace. The gas flow and temperature were measured by standard methods. The gases were analyzed by acid absorption or by Podbielniak distillation. Conversions were calculated from the gas analyses and the relative volumes of feed and effluent gases. The ratio between the amount of the desired olefin and that of the total olefins formed presents a ready means of following the efficiency of the dehydrogenation reaction, provided cracking to carbon is not extensive.

CHARACTERISTICS OF DEHYDROGENATION CATALYSTS

The activity of a dehydrogenation catalyst depends not only on its chemical composition but also on its physical structure. A compound can be quite inactive in one form or very active in another; the method of preparation is therefore of importance. It is often difficult to obtain a structure which is capable of catalyzing dehydrogenation; a carrier of active support possessing the required physical structure may render such a compound active.

It has been found that active dehydrogenation catalysts possess a high adsorptive capacity. However, this does not imply that a material having high adsorptive properties is necessarily an active catalyst. Activated carbon[5] and activated alumina are examples of materials having both high adsorptive capacity and high selective dehydrogenation activity. On the other hand, silica gel, which has a high adsorptive capacity, has shown very little activity as a dehydrogenation catalyst.

The presence of small amounts of water vapor, preferably introduced with the feed, is essential for

practical dehydrogenation activity. Many experimental results show that a dehydrogenation catalyst is active only when covered by a monomolecular layer of water.[2] The water may be substituted by hydrogen sulphide or a combination of the two gases.[8]

The active period of a catalyst is limited by many factors, such as clogging of the pores (for example, by carbon and tar), disruption of the physical structure (by excessive temperatures), and poisoning by foreign chemical compounds. A catalyst can generally be regenerated if its physical structure has not been destroyed.

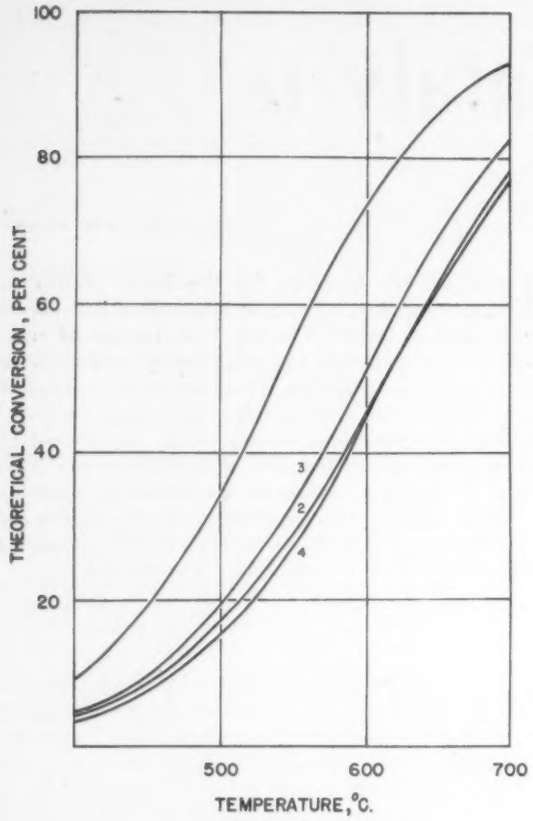

Figure 1

Dehydrogenation of Paraffin Hydrocarbons (Equilibrium Curves)

Curve 1.—Isobutane to isobutene.
Curve 2.—n-Butane to trans-2-butene
Curve 3.—n-Butane to cis-2-butene.
Curve 4.—Propane to propene.

ACTIVATED ALUMINA AS DEHYDROGENATION CATALYST

The particular form of activated alumina which has been found satisfactory as a catalyst for dehydrogenation is a commercial product of very porous structure, sold as a drying agent. This alumina is made by calcining a specially crystallized alumina trihydrate. In the laboratory an activated alumina which compares well with the commercial product was prepared by dissolving alumium in sodium hydroxide and precipitating aluminum hydroxide from the solution by means of carbon dioxide gas; the resulting precipitate was carefully washed and dried at 600° C.[6]

For the dehydrogenation of isobutane over this activated alumina the optimum temperature range is 585 to 650° C. for space velocities ranging from 2 to 75 per minute; for propane the optimum temperature range is 625 to 650° C. for space velocities between 5 and 20 per minute. At lower temperatures the rates of reaction decrease rapidly: at 550° C. very little reaction takes place. As the temperature is increased, reactions leading to lower olefins, carbon, and hydrogen increase. Yields of all products from two representative experiments with isobutane are listed in Table 1.

TABLE I

Dehydrogenation of Isobutane over Activated Alumina (6-hour composite samples)

Temperature, ° C.	600	650
Space Velocity, per minute	3.3	35
Isobutane Reacted, percent by weight	44.1	35.5
Conversion to Isobutene, percent	31.6	17.5
Yield, percent by weight:		
Hydrogen	4.2	2.4
Methane	6.6	5.2
Ethylene	0.6	0.8
Ethane	0.0	2.0
Propene	5.6	10.9
Propane	1.3	6.1
Isobutene	71.9	57.2
Carbon	9.8	15.4

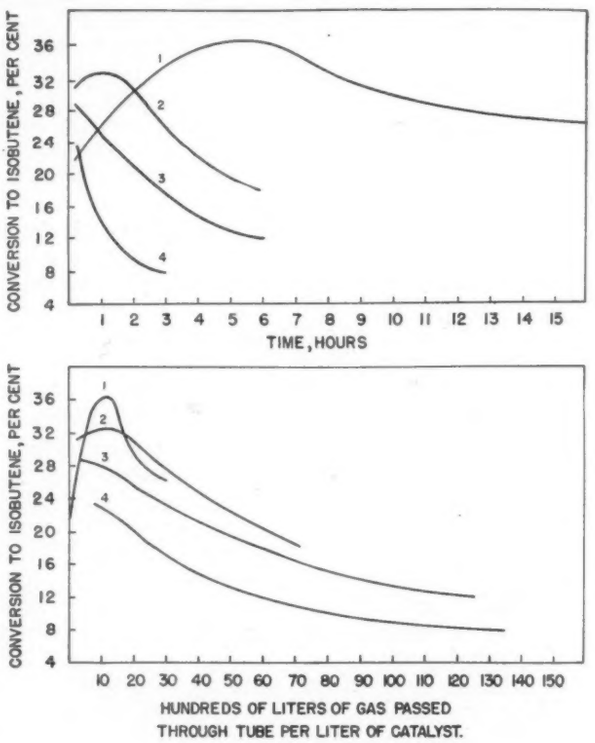

FIGURE 2

Dehydrogenation of Isobutane Over Activated Alumina Catalyst

Curve	Temperature, ° C.	Space Velocity per Minute	Ratio*	Duration of Run, Hours	Percent Average Conversion to Isobutene	Production†
1	600	3.3	.80	16	29.8	944
2	650	20	.74	6	25.0	1800
3	650	35	.71	6	17.6	2218
4	650	76	.71	3	12.0	1642

* Isobutene to total olefines.
† Liters of isobutene gas per liter of catalyst.

The course of the dehydrogenation is illustrated for isobutane in Figure 2 and for propane in Figure 3. In the upper curves of these figures the conversion is shown as a function of time; and in the lower, as a

function of the total amount of hydrocarbon which has passed through the reaction tube. From Figure 2 it will be seen that (after an induction period) the highest conversion to isobutene is obtained at the lowest space velocity (and temperature) and that the activity of the catalyst at this low flow decreases only slowly; experiments have shown that the conversion to isobutene does not fall below 20 percent over periods of 60 to 100 hours. There is, however, a much

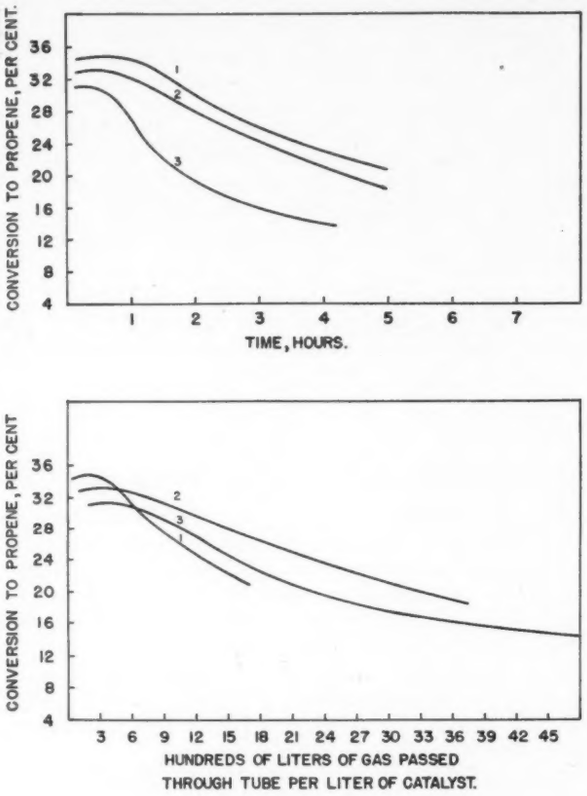
CONVERSION TO PROPENE, PER CENT.
TIME, HOURS.
CONVERSION TO PROPENE, PER CENT
HUNDREDS OF LITERS OF GAS PASSED
THROUGH TUBE PER LITER OF CATALYST.

FIGURE 3
Dehydrogenation of Propane Over Activated Alumina Catalyst

Curve	Temperture, ° C.	Space Velocity per Minute	Ratio*	Duration of Run, Hours	Percent Average Conversion to Propene	Production†
1.....	650	5.7	.84	5	28.1	480
2.....	650	12.5	.86	5	25.8	968
3.....	650	20.0	.87	4	20.9	1002

* Propene to total olefines.
† Liters of propene gas per liter of catalyst.

greater production of isobutene per unit period of time per unit volume of catalyst when high space velocities are employed, but in this case the activity of the catalyst decreases more rapidly, necessitating more frequent regeneration. The choice of space velocity thus depends upon the relative importance of these factors in the given application. Propane, as may be seen from Figure 3, behaves somewhat similarly, but the effect of space velocity on percentage conversion and decline of catalyst activity is much less pronounced; hence in this case high space velocities have a very definite advantage.

As mentioned above, the presence of a small but finite amount of water vapor in the hydrocarbon feed is of the utmost importance for successful catalytic dehydrogenation. In the case of activated alumina catalyst, the optimum water content of the feed is of the order of 0.1 mol percent; and this value is approximated by passing the moist feed over calcium chloride. When a feed is dried more thoroughly (for example, by means of phosphorus pentoxide) there is a definite decrease in the activity of the catalyst; and intensive drying (by means of triphenyl methyl sodium) results in complete loss of activity.[2] Moisture content higher than the optimum also leads to a rapid decline in catalyst efficiency. These facts are illustrated in Figure 4, where the maximum conversion, which may be taken as a measure of the activity of the catalyst is plotted against the molal concentration of water in the feed. The close regulation of water content is probably necessary not only to enable formation of a layer of water molecules on the surface of the catalyst, but also to maintain the alumina in the proper state of hydration. A similarly close relation has been found[1] between the water content of activated alumina and its adsorptive capacity toward hydrogen sulphide; this is of interest in view of our observations (discussed below) regarding the close parallelism between the adsorptive capacity of activated alumina for hydrocarbons and its activity as a dehydrogenation catalyst.

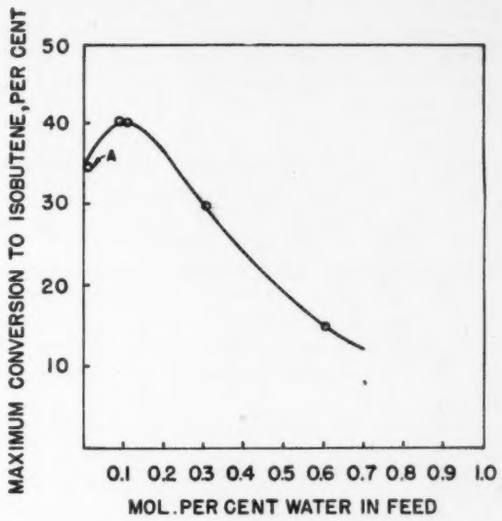

FIGURE 4
Influence of Water Vapor on the Dehydrogenation of Isobutane Over Activated Alumina

Space velocity, 3.3 per minute.
Temperature, 600° C.
Point A represents feed dried over P_2O_5.

ACTIVATED ALUMINA AS A CARRIER

While activated alumina is a good dehydrogenation catalyst in itself, its greatest usefulness lies in the fact that it is an excellent carrier or support for materials which are chemically active but do not possess the physical structure necessary for a successful dehydrogenation catalyst.

When other catalytic substances are placed upon activated alumina the dehydrogenation properties of the carrier and catalyst are combined. The degree of this change depends on the specific dehydrogenation properties of the added material and upon its concentration on the alumina.

When activated alumina is used as a carrier, it is impregnated with a solution of the desired compound. A successful procedure is as follows: The alumina is heated under reduced pressure to 200° C. to expel the adsorbed air. It is covered with the impregnating

TABLE II

Dehydrogenation of Isobutane with Activated Alumina and Added Compounds
(Space velocity 3.3 per min.)

ADDED COMPOUND	Temperature, ° C.	PERCENT CONVERSION TO BUTENE		Ratio*
		Maximum	3 Hour Average	
None	600	36.2	32.0†	.80
Chromium Oxide	550	38.0	36.2	.90
Vanadyl Sulphate	550	33.0	31.0	.89
Iron Oxide	550	37.2	35.2	.85
Zinc Oxide	600	35.2	26.7	.75
Reduced Nickel	500	14.9	.....	.90

* Isobutene to total olefins.
† 12 hour average.

solution and then cooled before releasing the vacuum. The impregnation can also be accomplished by letting the carrier stand for some time submerged in the solution at room or elevated temperatures.[7]

In many cases activated alumina improves the stability of the dehydrogenation catalyst which it supports. For example, chromium oxide in the form of an active gel is a selective dehydrogenation catalyst at about 400° C. giving conversions approximating equilibrium conditions. However, these conversions are low, because the equilibrium at such a low temperature does not favor the olefin (Figure 1); from this standpoint it would be well to operate at higher temperatures. However, this catalyst is unstable at 500° C. or higher. Since activated alumina has an appropriate structure which is stable above 500° C. it constitutes a very suitable carrier for chromium oxide, or for other catalysts.

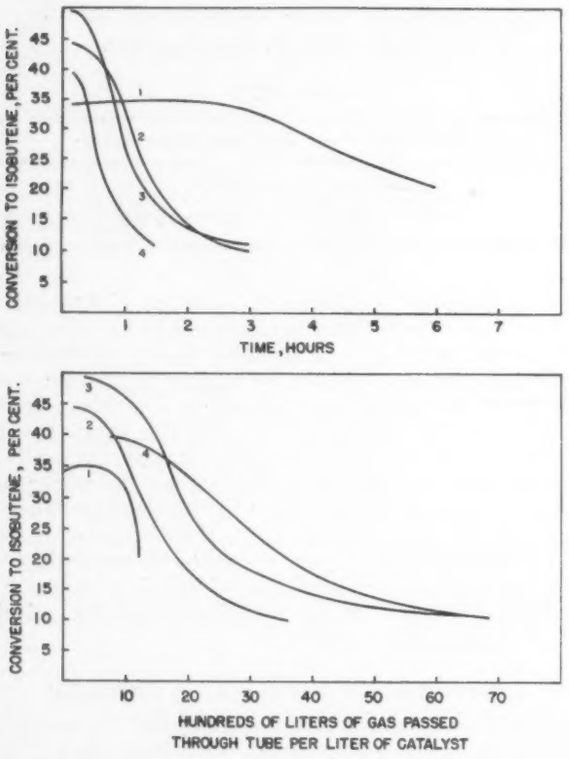
CONVERSION TO ISOBUTENE, PER CENT.
TIME, HOURS
CONVERSION TO ISOBUTENE, PER CENT.
HUNDREDS OF LITERS OF GAS PASSED THROUGH TUBE PER LITER OF CATALYST

FIGURE 5
Dehydrogenation of Isobutane Over Chrome-Alumina Catalyst
(12.7 Percent Cr.)

Curve	Temperature, ° C.	Space Velocity per Minute	Ratio*	Duration of Run, Hours	Percent Average Conversion to Isobutene	Production†
1	550	3.3	.91	6	30.5	366
2	550	20	.83	3	25.0	899
3	575	35	.83	3	24.3	1532
4	625	76	.78	1½	21.6	1478

* Isobutene to total olefines.
† Liters of isobutene gas per liter of catalyst.

Some contact materials are such active catalytic agents that the reaction is carried too far, so that splitting of the carbon-to-carbon bond occurs. Mounting such catalyst on the activated alumina carrier modifies this activity. For example, reduced nickel oxide on pumice is very active but causes complete cracking to carbon and hydrogen at temperatures as low as 450° C., whereas nickel on activated alumina gives favorable conversions and ratios. Similarly, iron oxide when prepared as an active gel favors disruption of the hydrocarbon molecule, but is a selective dehydrogenation catalyst when supported by activated alumina.

Catalysts consisting of reduced nickel, oxide of chromium, iron, vanadium, and zinc, and many other active materials, supported on activated alumina have been tested. Representative results, listed in Table 2, illustrate the suitability of activated alumina as a carrier.

CHROMIUM OXIDE ON ACTIVATED ALUMINA

Chrome-alumina catalysts are prepared by impregnating activated alumina with an aqueous solution of chromic acid or one of its salts, such as sodium or potassium chromate or bichromate. Catalysts prepared with alkali chromium salts give most satisfactory conversions with concentrations of about 2 percent chromium; if the salt content is increased beyond the optimum figure the activity of the catalyst decreases owing to the increasing formation of an alkali aluminate.

The presence of alkali may be avoided by the use of chromic acid or chromium nitrate in the preparation of the catalyst. In this manner, on raising the chromium concentration to 10 or 20 percent, a catalyst is obtained which is active at temperatures 50° to 70° C. lower than for activated alumina containing little or no chromium oxide. This flexibility is of advantage, because it enables a choice of catalyst to suit the particular hydrocarbon from the standpoint of equilibrium and thermal stability. For example, normal butane, which is less stable thermally than isobutane or propane, is best dehydrogenated by means of a catalyst of high chromium concentration, which is active at lower temperatures. Propane, which is stable at higher temperatures, is on the other hand preferably dehydrogenated by means of a catalyst of lower chromium concentration.

Figure 5 gives conversion data for isobutane using a chrome-alumina catalyst containing chromium oxide (12.7 percent Cr.). In comparing the conversion curves for this catalyst with the conversion curves for plain activated alumina (Figure 2), two important points may be noted: first, that the temperatures are lower, and second, that the runs are shorter in duration. However, higher initial conversions, better ratios of isobutene to total olefins, and higher yields result with the chrome-alumina catalyst. The yields are 75 to 80 percent at space velocities between 20 and 75 per minute and corresponding temperatures in the range 550° to 600° C.

A comparison of the behavior of the three hydrocarbons over representative alumina catalysts, with

TABLE III

Dehydrogenation of Propane, Normal Butane and Isobutane with Alumina Type Catalysts

(Space velocity = 20 per minute)

	Activated Alumina	Activated Alumina + 2 Percent Cr.	Activated Alumina +12-15 Percent Cr.
	3-Hour Period	1½-Hour Period	1-Hour Period
Propane:			
Temperature, ° C.	650	625	575
Average conversion to propene, percent	23.6	37.4	25.8
Average ratio of propene to total olefins	.87	.95	.95
Normal Butane:			
Temperature, ° C.	650	625	550
Average conversion to normal butene, percent	*	22.0	30.1
Average ratio of normal butene to total olefins	*	.60	.97
Isobutane:			
Temperature, ° C.	650	625	550
Average conversion to isobutene, percent	31.0	35.5	37.0
Average ratio of isobutene to total olefins	.74	.78	.83

* Excessive decomposition to carbon and hydrogen; in the other eight examples, carbon formation was only 1 to 4 percent (feed basis).

and without chromium oxide, is given in Table 3. Suitable operating temperatures were selected in each case for the particular hydrocarbon feed and catalyst, at a uniform space velocity of 20 per minute. The conversions and ratios of olefins are average values over the periods of time listed; these periods correspond roughly, as may be seen by comparison with Figures 2, 3, and 5, to those during which the catalysts are reasonably active, and therefore to practical lengths of runs, at this space velocity.

Experiments have shown that the catalytic activity of activated alumina closely parallels its adsorptive capacity. Hence in view of the change in activity produced by adding chromium compounds to activated alumina, tests of adsorptive capacity have been extended to these catalysts.

These measurements, summarized in Figure 6, show that the more active catalysts have the greater adsorptive capacity. The presence of an alkali radical in high concentrations (for example, from the use of sodium bichromate), which as above stated is detrimental to the activity of the catalyst, is also detrimental to the adsorptive capacity (compare curves 4 and 5 with curve 3). On the other hand, the introduction of chromium as chromic acid materially improves the adsorptive capacity (curves 1 and 2). The addition of 15.1 percent chromium, as chromic acid, produces a catalyst which does not materially decrease in adsorptive capacity until heated to temperatures in excess of 700° C.

REGENERATION OF CATALYSTS

The activity of these catalysts declines as a result of the accumulation of carbon upon the surface and in the pores of the catalyst during the dehydrogenation process. To restore the original activity of the catalyst, this carbon deposit must be periodically removed. The removal is best accomplished by treating the catalyst at a temperature of 600° to 700° C. with a stream of air. The heat of combustion is sufficient to cause a sharp rise in the temperature of the

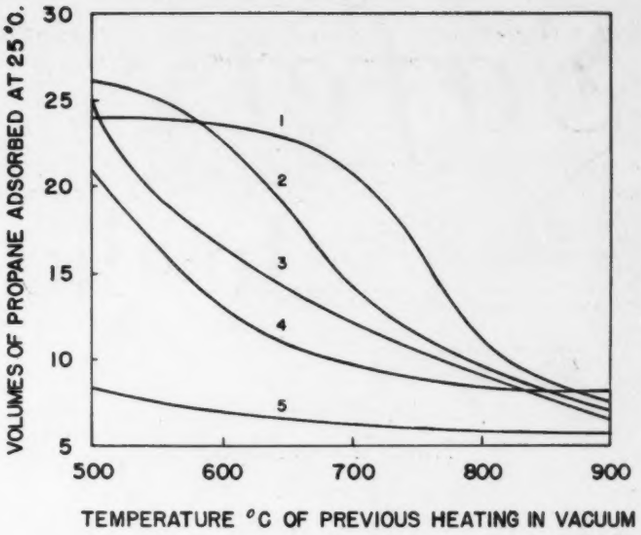

FIGURE 6

Adsorptive Capacity of Alumina Type Catalysts

Curve	CATALYST	Percent Cr.
1	Chromic Acid Alumina	15.1
2	Chromic Acid Alumina	1 9
3	Activated Alumina	0.0
4	Sodium Bichromate Alumina	7.5
5	Sodium Bichromate Alumina	15.0

catalyst bed, and the air flow must be carefully controlled in order to keep the temperature within safe limits, of the order of 700° C. The time necessary for regeneration can be reduced to one half or one third (without at the same time permitting excessive temperatures) by diluting the air with an inert gas such as nitrogen or carbon dioxide, or in some cases, steam; these diluents serve to increase the rate of removal of the heat generated in the tube.[6,7]

In actual practice the course of the regeneration may be followed by the course of the "hot spot" or combustion zone which progresses from the inlet end of the tube to the exit end. When this "hot spot" reaches the exit end, there is a sharp decline in temperature and decrease in the carbon dioxide content of the effluent gas; the catalyst is then ready for re-use.

Both the plain activated alumina and the chrome-alumina catalysts have been regenerated in this manner over 200 times with very little loss in activity.

PATENTS

Various features of these processes are covered by patents and pending applications in the United States and abroad.

ACKNOWLEDGMENT

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Safety...

In the Gasoline Plant

J. A. CAMPBELL
Natural Gas Engineer

THIS discussion of safe practices in natural gasoline manufacture from Julian Campbell involves no preachment on the subject. Rather, the discussion most interestingly presents information of the proper safeguarding of gasoline plant equipment of practically all types, and deals principally with matters not usually looked into by the insurance inspectors. There is much of value in the article, not alone for the natural gasoline industry but also for those engaged in the refineries where gasoline plants, gas plants, stabilizer systems and similar processes are in use.

"SAFETY FIRST" has become a national shibboleth. But when we say "safety first" do we really take cognizance of the significance of the slogan. Most of us actively engaged in the manufacture of this "liquid dynamite" feel safer when we are within the plant yard than we do when driving our cars through busy streets or along the highways, and we probably are. Nevertheless, once in a while a disaster occurs in one of these plants and the newspapers of the country give it wide publicity so that the general public forms the opinion that a natural gasoline plant is a very undesirable neighbor and the industry suffers accordingly. Of course, the first consideration of any safety engineer is the prevention of loss of life and personal injury but there are decided economic advantages to the industry in keeping the slate clean.

If we take "safety first" seriously we give careful attention to the laying out of our plants from the angle

Showing proper method of protecting a battery of boilers by means of a retaining wall.

The plant of Lomita Gasoline Company, Mountainview, Kern County, California, is an example of a well laid out natural gasoline installation.

of safe operation. A modern gasoline plant is a decidedly different affair from the plant of 15 or 20 years ago. For one thing we do not have "look-boxes." To be sure, the stockholders cannot see the production stream but it is better that they defer their view of the pearly gates than that they be privileged, on each inspection trip, to size up the production through a dirty and often-times cracked piece of glass. The operator gets his hourly gauge quite accurately in the pressure tanks and the look-box has been relegated to the Dark Ages.

Pressure tanks have replaced open storage and the vapors that leave them are recycled. Vent tanks have been found to be unnecessary except on high-pressure operations and when used, such vapors as they discard are piped back into the system. Today we have much better designed glands and better packing on valve stems, pump and compressor rods. Gauge glasses are of better material and break much less often, gaskets are tougher and more resistant to softening, dies are harder and cut sharper, truer threads and this, together with the fact that we have better pipe dope, has largely eliminated thread leaks. And the welding torch and arc, in combination with steel flanges and welding fittings have done even more to eliminate thread leaks.

There is little danger of fire and explosion unless there is a break or a blow-out, so it is well to locate the boilers, the one ever-present source of ignition, well away from the equipment and tankage.

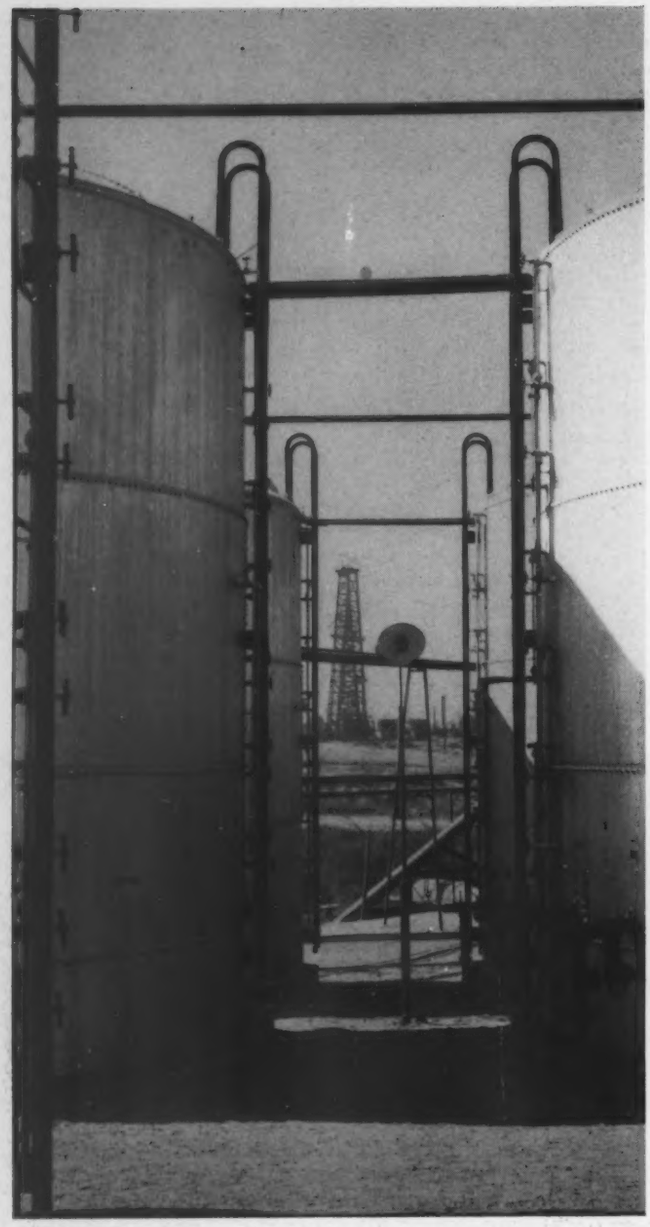
If the boilers are on lower ground than the plant proper, they should be protected by a retaining wall. Storage, where possible, should be well away from the boilers and on lower ground when convenient. A good arrangement is effected by placing the cooling tower between the boilers and the storage. When the gasoline plant is located in a section of the country where the wind is usually from one direction, it is well to locate the boilers on the windward end or side of the plant. Drainage pits should also be located well away from the boilers.

Assuming that the plant is properly laid out, what are the sources of greatest danger in operation?

Stabilizers are usually operated at pressures of from 150 to 250 pounds per square inch. The stabilized gasoline passes out usually through the exchanger then through a float-controlled valve and cooling coils to the storage tanks which are not usually designed for a safe working pressure in excess of 30 pounds per square inch. Should something lodge under the valve or should the valve stick, there is a possiiblity of building up considerable pressure on the storage. A small float valve, ¼-inch or ⅜-inch, with this high differential, will pass a large amount of liquid and yet will act as a retarder to vapor flow so that the relief on the storage will have sufficient capacity. If the final cooling coil is built of small pipe, this also acts as a restriction and due to higher velocity and greater turbulence, affords more efficient cooling. All of the storage tanks should be connected near the top. This makes all the reliefs available if vapors start building up excess pressure and affords added insurance. This is also a wise provision in preventing the over-filling of any tank. If the final gasoline cooling coil is of sufficient length and small enough in cross-section, the chances are it will be able to condense all the vapors that could pass through it.

FILLING TANKS

A serious danger exists where a high-pressure pump is discharging into a low-pressure tank if there is any possibility of the tank completely filling. Such tanks are usually equipped with vapor-relief valves



Details of method of inter-connecting storage tanks at the top.

which are not designed to relieve liquid pressure. A "hammer" is very likely to set in, which will rupture the tank. If such a combination exists in a plant, protection should be furnished by means of setting a high level float with electric or whistle alarm. A liquid-relief valve will not afford protection unless set at a lower pressure than the vapor-relief.

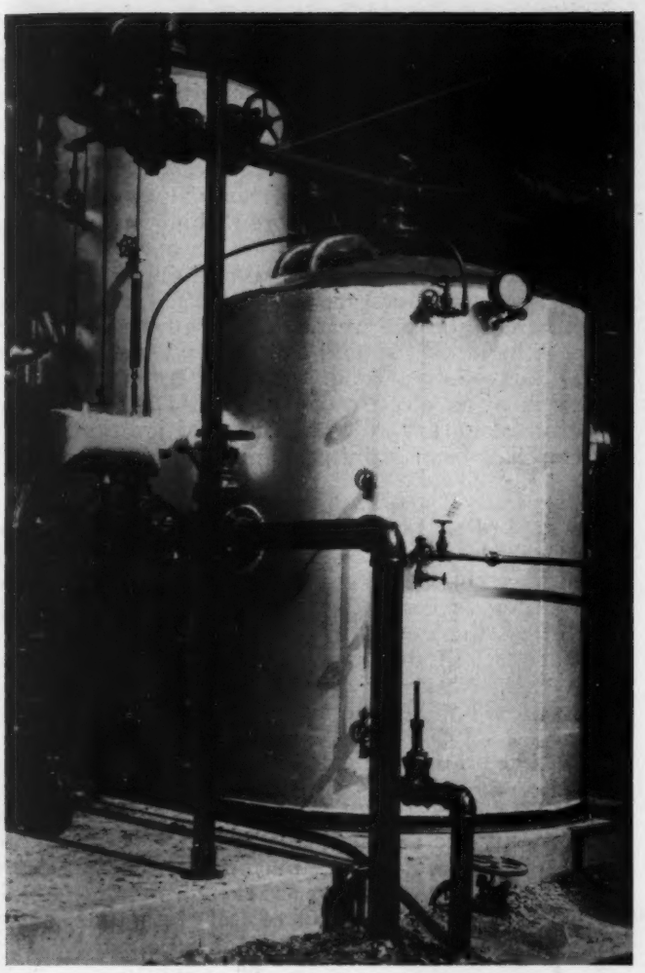
Compressors handling gas or vapors should be protected by adequate scrubbers to catch any liquid coming through. This is especially true of compressors handling gas from the field because a trap valve is likely to stick, allowing a slug of oil to come through with the gas. Such scrubbers should be equipped with automatic float-controlled valves or if operating on a vacuum, with float-actuated alarms. Ample provision should be made for quickly draining these scrubbers. No one wants to blow out a cylinder head.

Gas leaks in the compressor house should not be tolerated. An explosive mixture is easily ignited by the magnetos. Compressor houses should be well ventilated by pent-house louvers or ventilators of ample size. When heavy vapors are being pumped, louvers should be provided at the floor level. Exhaust gaskets and packing should be kept tight.

Another potential source of danger exists in the starting-air piping in the compressor plant. Starting compressors are often single-stage and the heat of compression is high. Lubricating oil is vaporized sometimes in sufficient quantities to form an explosive mixture with the compressed air. Sometimes the entire air-starting piping is ripped from the machines and the air storage tanks have been known to explode. In one case the mixture was too lean to explode because of the high volume of air, but slow burning in the long three-inch horizontal air line heated it red hot, causing it to sag.

The best way to prevent such an occurance is to install in the air line near the compressor, an efficient mist extractor, preferably with a long, slender reservoir, with a gauge glass near the bottom. This should be kept drained as also should the air receivers. As an added precaution, if the line from the compressor to the air receivers is long, it is well, on the down stream side of this separator, to have a connection with a valve on the bottom of the line. Once a month, or oftener, it is advisable to blow the air back from

Mist extractor on air line from starting compressor for throwing out oil and water mist.



Spring balanced, outside float for handling uncondensed still vapors from dewatering tank on the end of condensers.

the receiver through this outlet to sweep out any accumulation of oil in this line. It is considered good practice to use two check valves on the air piping to each engine because of the possibility of a piece of hot carbon or burning gases shooting through a partly-closed check and igniting an explosive mixture caused by part of the gas charge leaking through.

GAUGE GLASSES

Breaking gauge glasses have caused serious accidents. Fittings should be of the safety type so that they will shut off automatically when the glass breaks. Gauge glasses should not be removed from the fittings for cleaning. It is best to leave them in place and pour a solvent or cleaning compound through them. Experience teaches us that glasses taken out to be cleaned and then put back very soon fail.

A great deal of painting has to be done on gasoline plants, especially if they are near the ocean. Hidden around them somewhere, often in a corner of a warehouse, you will find an aggregation of partially-filled paint cans, buckets and old brushes, and painters will use rags. Paint itself is highly inflammable and an oily rag is potential fire. It costs very little to throw up a small iron-clad welded-pipe-frame building and put on a door. If put in some isolated corner of the yard and used to house all the painter's supplies and equipment it will add to plant safety and will very likely please the painter.

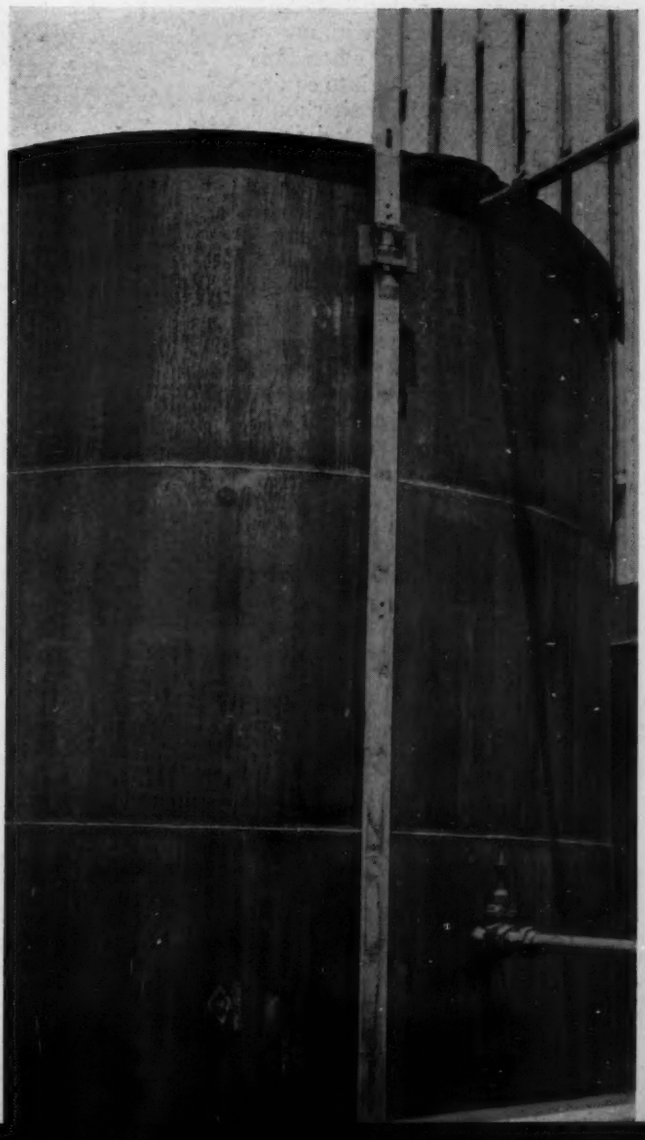
When they get along in years, leaks will occur in the best of gasoline plants. At most of the old plants will be found a generous supply of pipe clamps. These should be regarded as only temporary means of repair and when used, their location should be listed in the superintendent's book so that none of them might be overlooked at the next shut-down. Any repairs that must be made at time of shut-down should be noted in the book, because it is easy to overlook a condition which, if allowed to continue, might cause an unnecessary shut-down or even an accident.

PIPES SHOULD BE BRACED

Vibrating pipes should be braced. Vibration will eventually loosen up something and cause a leak. Long vertical pipes subject to expansion through temperature changes should be supported on heavy coil springs. If ladders are used on cooling towers the rungs should be notched in to the standards and then a retainer strip nailed over either side. The spray from a cooling tower will badly rust nails and rungs will easily pull from a ladder which has been in service several years unless such a precaution is taken. Ladders should be periodically inspected and new nails put into the retainer strips. We will not go into the advisability of protecting pits with hand rails and moving machinery with guards since the insurance inspectors usually catch things like this.

Smoking is often permitted in the offices and in the laboratory. This may be perfectly safe in normal operation but under certain conditions might prove

Sight indicator attached with cable to float in drips storage tank.



disastrous. When any repairs or changes are to be made in the plant, which involve the possible release of gas, gasoline or vapors, the man in charge should notify the men in the office and the laboratory so that all smoking ceases and all open flames are extinguished and electric heaters cut off. Bright warm days should be chosen for such work where possible, and care should be taken if there is a breeze that it be from the boilers and not towards them.

Welding is employed widely in building modern plants and consequently the cutting and welding torch and arc are used extensively in making repairs, additions and replacements. Work of this nature involves a certain amount of danger and should be handled only by experienced men. The following paragraphs will outline safe practice for some of the work that is often done around a gasoline plant.

Assuming that an old plant has pipe coils for oil cooling and it is desired to replace them with new pipe, what is the proper procedure? If it is a single-unit plant, naturally the work will want to be handled expeditiously so that no serious loss in production will result. By connecting a line from the lowest point of the coils to the oil storage and then connecting dry gas to the high point, most of the oil may be blown out into storage. Replace the gas connection with a steam connection and the coils can soon be made safe for cutting with the torch. Have a small amount of steam passing through when the first cuts are made.

LINE TAPPING

Line tapping is used a great deal in absorption plants. It can be done with the tanks, pressure vessels and lines carrying full flow and full pressure and permits changes and installations of new equipment without a shut-down. However, when it is necessary to torch-cut into equipment, that particular unit should be completely disconnected from any line that might carry gas, oil, vapor or gasoline or else thoroughly blanked off. Steam should be admitted to the top and should flow freely through and out at a vent near the bottom. Leave the steam on for several hours and have it passing through when the cut is made. If it is necessary to cut the top off a tank, evaporator or absorber, it is good practice after steaming to fill the shell with water up to the line of cutting. Always have fire extinguishers standing by when using the torch. You may not need them but if they are there and the fire is started, it can be controlled quickly. When cutting into vessel, have as many vents as possible open so if there is a shot, it will not rupture the shell. Never permit the welder to stand in front of an opening when cutting into a shell. This procedure should not, of course, be followed when cutting into a line carrying gas. The pressure should be reduced to slightly above atmosphere and then the cut made. There is not any danger of explosion in cutting into a line carrying pure gas or vapor; there is danger of fire, but it requires a mixture with air to form an explosion.

Never cut into a vacuum line with a torch, there is a possibility of its carrying an explosive mixture. When cutting into lines, see that they are disconnected or blanked off from any tankage or vessels, no matter how far away. Never trust valves, close them and then blank them off before making your cut.

It is an unsafe practice to use an electric drill for drilling into a pipe or vessel containing gas or near where gas or vapors are escaping. The sparks from the commutator will readily ignite an explosive mixture. A hand drill should be used and the bit should be well covered with cup grease. There is a tendency to think of an electric drill as a tool and to be unmindful of its hazard as a source of ignition. Many a man has been painfully burned by making this mistake.

IN CASE OF FIRE

In case of a fire in a plant, it is natural for the inexperienced operator to shut the plant down, though sometimes this is the most serious mistake he could make. Let us consider a case in point. Suppose a gasket on the fat oil circuit at the heat exchanger blows out and the vapors drift to the boilers and flash back. Naturally oil will collect under the heat exchangers and intense heat will envelop the flanges. If the fat oil pump is slowed down and the fire extinguisher brought into play, it is likely that the fire may be put out even with some flow escaping from the ruptured gasket. If, however, the flow is stopped by shutting the oil pumps down, there is nothing to carry off the heat from the burning oil and the flanges may crack, throwing the full flow of oil into the flames, thus making a fire that cannot be extinguished with equipment at hand. In one case a fire developed in a stabilizer plant and gasoline on fire ran under some of the absorption equipment. The plant could have been saved by shutting down the stabilizer and keeping the oil circulating. However, the entire plant was shut down and the heat melted brass valves, releasing the absorption oil and feeding the fire. The still, being shut in, popped, and the vapor flow ignited and burned up the cooling tower.

Spring mountings, check valves and swing joints on long vertical lines handling feed and reflux to a 42-plate stabilizer.

Every operating company should have one man who devotes a considerable portion of his time to safety. He should have safety meetings with the operators and depict imaginary fires in certain parts of the plant and ask the operators what they would do in such cases. He should advise them wisely on safety matters and gain their confidence in reporting to him what they regard as dangerous conditions in the plant, and he should take steps with the management to see that such conditions are eliminated.

New Tube Still

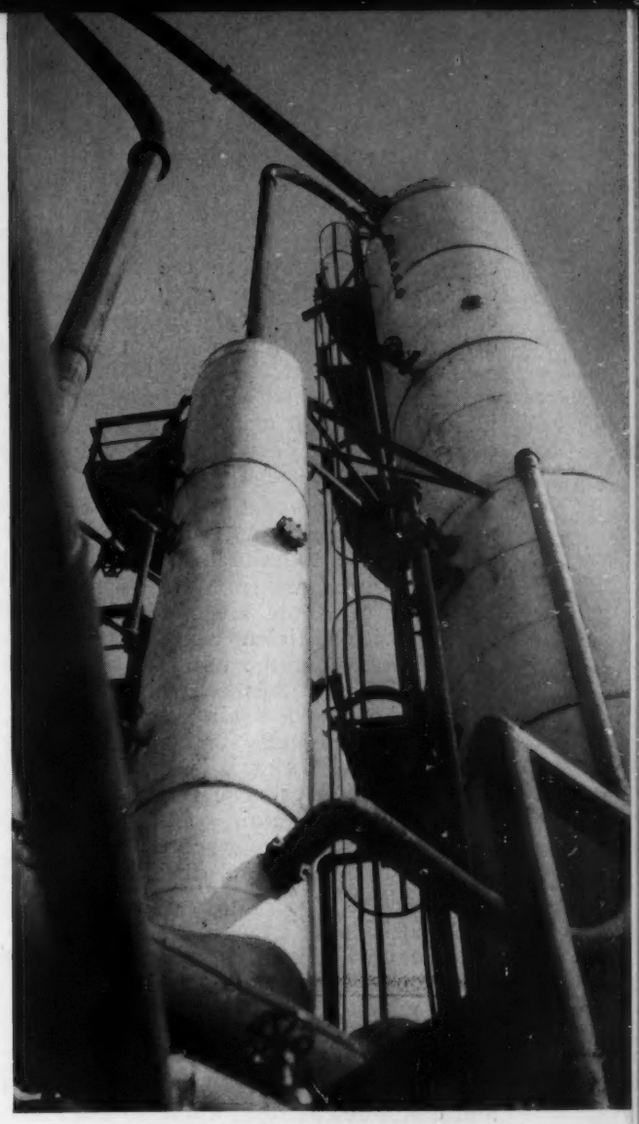
Improves Efficiency at Bristow Refinery

J. C. ALBRIGHT

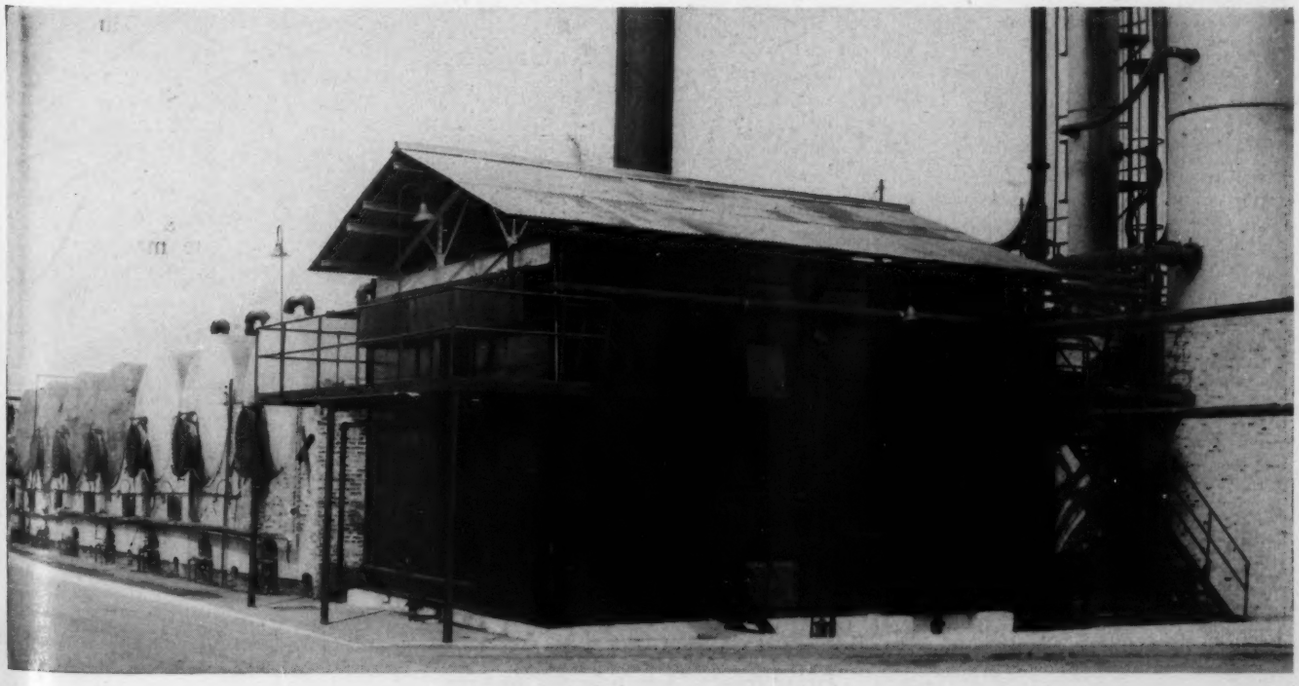
WHEN changing over its crude distillation operations in the refinery at Bristow, Oklahoma, Ohio Oil Company placed in the discard one of the last batteries of shell stills operating on crude in this part of the country. However, these shells were not of the ordinary type of stills that had been operated in the past in many refineries, but had been designed by company engineers as pressure vessels, connected in a battery of four shells each, and operated in conjunction with a modern bubble tower for fractionation. The efficiency of this battery is about equal to modern pipe still operation, outside of the time required to bring them on stream after a shut-down, and the consumption of fuel. The stills have not been entirely abandoned, and are used occasionally to refine a special batch of oil.

The pipe still recently constructed to replace the former operation carried on for the manufacture of straight-run gasoline, solvents, naphthas, kerosene, home burning oil, gas oil and reduced crude, was designed by Ohio Oil Company engineers.

All material going into the design of the pipe still



Fractionating column, side stripper, vapor line and kerosene distillate draw-off piping in Ohio Oil Company's Bristow Refinery.



New crude topping unit which replaces pressure type shell still operation. Capacity of new unit is 3,500 barrels at transfer temperature of 495° F.

was either new, or practically so, including refractories, burners, fire-brick walls, tube hangers, steel sheathing, roof, steel framework, tube headers and control instruments. In the design of the furnace, the engineers, after investigation, decided that tubes could be economically utilized that had been used once in the cracking plant at the refinery. These tubes, of the material usually required for reduced crude cracking, had become eroded beyond the stipulated safety factor near the ends and where they were connected to the headers, and could not be used in the cracking furnace again.

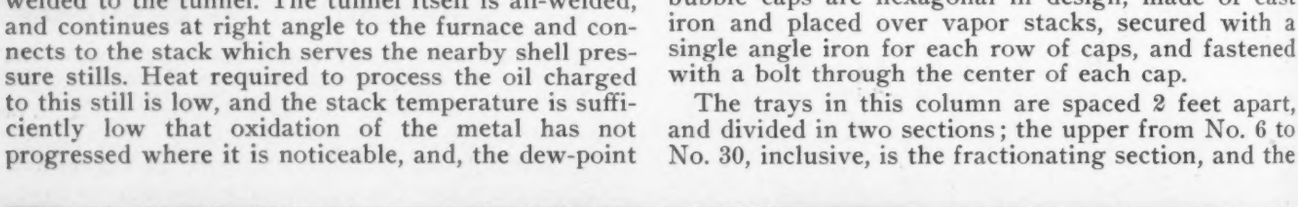
As a consequence, the pipe still being designed was revamped before construction had begun, to accommodate these tubes which had been cut to 22 feet lengths, which measurements were decided upon so that at any future time, additional tubes could be secured with sufficient working stock to replace those which might become unfit for use through wear in service. These tubes are 4-inch O.D. and 3¼-inch I.D., carbon steel, equipped with regulation headers and removable plugs for inspection and cleaning out during shut-down periods. They are arranged in two banks, the convection section containing 60 tubes, and the roof bank containing 37 tubes, with the oil in process flowing upward from the lowest tube in the convection bank, through the roof tubes and the transfer line.

Disposition of gases from combustion of the fuel is accomplished by using a draft tunnel, placed on the grade behind the furnace, and made from sections of a stack which had been taken down. The tunnel is connected to the furnace in two places, each near both sides of the lower back wall, by steel breeching, welded to the tunnel. The tunnel itself is all-welded, and continues at right angle to the furnace and connects to the stack which serves the nearby shell pressure stills. Heat required to process the oil charged to this still is low, and the stack temperature is sufficiently low that oxidation of the metal has not progressed where it is noticeable, and, the dew-point of the gases is not reached before they enter the brick foundation of the stack, consequently corrosion from this source is practically impossible.

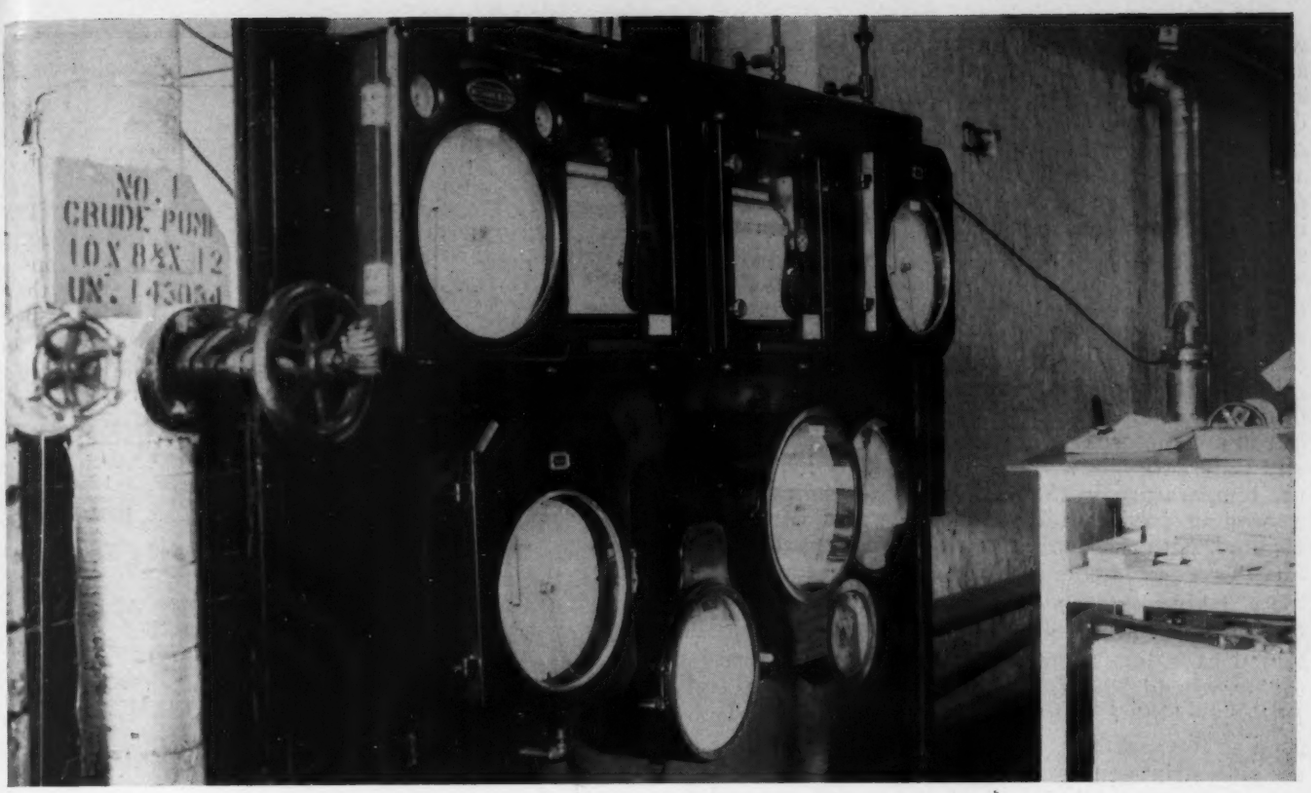
Firing is accomplished on the front of the unit only, requiring four burners in sections of two each, which are controlled with an automatic firing device actuated by an instrument on the control panel. The reduction of fuel used by this pipe still, when compared with the overall operation of the continuously connected pressure shell stills is said to be more than $10.00 per day. The flexibility of the pipe still is such that it can be brought on full stream, if required, in three hours from the time the burners are lighted. With a normal charge of 3500 barrels per day, the fuel consumed in the combustion chamber is approximately 285,000 cubic feet per day. Temperatures being so far below the usual pipe still operating conditions do not cause a deposition within the tubes, and upon an inspection after several months operation, no scale or coke was found, but the tubes had an oily look, showing that the metal was clean.

The fractionating equipment includes two columns; the main tower is 8 x 91 feet, and the secondary column consists of three sections for stripping products taken from draw-off pans below the gasoline vapor line. The main column contains 30 trays, all steel, welded and annealed before shipment. The bubble trays are mounted on 2½-inch rings, welded to the inner wall of the shell, and secured with machine bolts placed at intervals around the circumference. A vapor-tight joint is obtained with asbestos rope securely rammed in place between the rim of the bubble tray and the supporting ring, sealed with a compound which is resistant to moisture and oils. The bubble caps are hexagonal in design, made of cast iron and placed over vapor stacks, secured with a single angle iron for each row of caps, and fastened with a bolt through the center of each cap.

The trays in this column are spaced 2 feet apart, and divided in two sections; the upper from No. 6 to No. 30, inclusive, is the fractionating section, and the



Firing front of new tube still furnace.



Instrument panel in control room for operating new crude unit.

lower containing 5 trays is the vaporizing, or stripping section. Draw-off pans are made in two designs. The first from the bottom, being the gas oil accumulator, is a standard bubble plate, but having a 3-inch pipe flanged to one side of the tray, smooth faced at the punched hole for a full-face gasket. The connections are malleable iron, and are installed for ease in removing, by unbolting the tray flange and a gasket flange between two nipples. The other type of draw-off connections, covering kerosene, naphtha and solvent collectors have two openings in the face of the tray, directly across from each other, and are attached to the lower side of the tray with full-faced flanges with gaskets for sealing. They join a common outlet pipe near the center of the tray, and are connected to the tee with nipples and flanged gaskets.

Nozzles which are used to withdraw products are sweep type, and welded to the outer surface of the column, as well as where the holes are made for the outlet in the inside. A collar is welded to the inside of the nozzle to which the draw-off piping is attached, and may be 2-inch or 3-inch, depending on the needs. Some of each draw-off connections are 2-inch, and others 3-inch, depending upon location in the column and to which tray they are connected.

A 12-inch nozzle is welded to the upper section above the last tray for removal of gasoline vapors, and a 3-inch nozzle is welded just above the lip of the top tray for introducing reflux for top tower temperature control and endpoint balance of gasoline manufactured. The solvent connections are made to four trays: Nos. 25, 26, 27, and 28, all with 2-inch connections and nozzles, and any or all of the draw-off pans may be used, as the need indicates. Naphtha connections and draw-off plates include trays Nos. 20 and 21, fitted with 3-inch connections, but arranged in the same manner as the solvent connections are made. Kerosene draw-off plates include Nos. 12 and 13 trays, both being equipped with 3-inch fittings. An 8-inch nozzle is attached to the column, in the 8-foot section between the fifth and sixth plate for transfer line connection, and a 12-inch nozzle is attached to the column below the first tray for vapors to enter which may be processed from material in any of the shell stills, which may be used at times while the pipe still is being operated on fresh crude. The reduced crude outlet is attached to the center of the semi-elliptical head in the lower end of the column, and is of welded construction the same as all other nozzles on the column.

The plant has a variable capacity, ranging from 2000 to 4500 barrels per day depending primarily upon reduced crude requirements of the cracking plant on the other side of the plant. Ordinary operation requires that approximately 3100 barrels of crude be charged the pipe still daily, with the crude picked up by a 10 x 8½ x 12-inch duplex steam-driven reciprocating pump and discharged at an average process pressure of 125 pounds at the outlet of the fluid section of the pump. The flow of the oil, as it leaves the pump, leads the charge through a vapor-to-charge exchanger placed above the roof of the pump house, and which may be by-passed if conditions warrant. The oil is then passed through a shell-and-tube unit through which the reduced crude flows as it passes from the column, with the charge heated to an average of about 205°F., when it enters the first coil in the pipe still.

Leaving the pipe still heating coils at a temperature of about 490-495°F., the charge enters the fractionating column through the 8-inch nozzle above the fifth stripping tray. The various products are removed from the tower at the trays previously described and vary in volume with the character of the crude processed. In ordinary operation, the gas oil is not removed from the charge, but is allowed to collect

with the reduced crude for cracking later. Usually, and except in extraordinary conditions, only gasoline, kerosene distillate and home burning oils, with reduced crude as bottoms, are recovered from the charge, but by varying the operation and taking advantage of the facilities incorporated in the column, many different products may be manufactured including wax distillate and reducing the residuum to steam-refined cylinder stock.

With present operation, the gasoline removed from the top tray, or section of the column is refluxed to a temperature of 272°F. by pumping back to the tower, the distillate condensed and accumulated in the receiver. The amount of reflux required varies with the operating conditions and the condition of the weather, but is not metered to determine the exact amount at any time. It is known, however, that by maintaining the temperature on the outlet of the gasoline vapors, a product having a desired end point will be recovered, with the distillation range being such that it fills the requirements for that class of motor fuel.

In making kerosene distillate and home burner oils the two trays provided as draw-off sections are maintained at a temperature of 375°F. on the kerosene top tray, and 395°F. on the kerosene bottom tray. Either, or both of these draw-off connections may be used as the case may be, with the product flowing to the side stripper to remove any lighter fractions that may condense on the accumulator pan. Some process steam is used in both the main fractionating column and the side stripper, but not being metered, the amount may vary within close limits.

When operating on straight Dutcher sand crude, having a gravity of 31.5° A.P.I., with a BS&W content of 0.7 percent, the results are as follows:

SR Gasoline	Naphtha Solvent	Kero-sene	Reduced Crude
Gravity 60.3	46.3 47.1	42.4	23.0
IBP. 106	288 326	370	520
10% off 125	330 330	398	4%.....550
20% off 206	344 338	408	16%.....600
50% off 248	366 348	432	30%.....650
90% off 326	392 372	472	
Maximum°F 394	427 404	528	
Color 30	28 28	21	
Octane 51			
Yield Percent ...22.32	1.52 0.66	12.01	62.14

Loss, 1.35%.

By running the reduced crude to the cracking plant, the results are as follows:

Gasoline		Fuel Oil	
Gravity	61.2		11.8
IBP	92	Flash	310
10% off	120	Fire	420
20% off	148	Vis at 122°F	275
50% off	346	Pour	35
90% off	376	BS&W	0.3%
Max	404		
Color	12		
V.P. 11.5	lbs. Reid		
Octane 71.0			

Gasoline yield .....42.2 %
Fuel Oil Yield 51.53%
Gas & Loss 6.27%

When the plant is operated on a charge comprised of 50-50 Dutcher sand and Seminole crude, the results are as follows:

Charge gravity 35.7
BS&W 0.3%

SR Gasoline	Kero. Dist. or Burner Oil	Gas Oil	Reduced Crude
Gravity 60.0	42.2	33.4	16.9
IBP 102	360	342	Flash 440
10% off 168	400	510	Fire 530
20% off 196	414	568	Vis at 122.. 277
50% off 260	442	612	Pour 35
90 350	490	736	BS&W ...0.3%
Max 400	522	760	
Color 30	30	5D Union	
Flash	150	110	
Fire	170	210	

Yields

Gasoline 29.69%
Kerosene 12.18%
Gas/oil 8.01%
Reduced crude 48.44%
Liquid recovery 98.31%
Loss 1.69%
Total 100.00%

When the plant is operated on straight Seminole crude, the results are as follows:

Crude gravity .....36.6° API
BS&W 0.2%

SR Gasoline	Kero. Dist. or Burner Oil	Reduced Crude
Gravity 61.3	42.3	27.0
IBP 102	352	510
10% off 166	398	15%.....600
20% off 198	412	32%.....650
50% off 266	448	
90% off 366	512	
Maximum 402	550	
Color 30	30	
Octane 51		
Fire	150	
Flash	170	

Yields on Above Charge

Gasoline 28.63%
Kero Dist, or burner oil..... 13.87%
Reduced crude 56.03%
Liquid recovery 98.53%
Loss 1.47%
Total 100.00%

By cracking the above reduced crude, the results are as follows:

Cracked gasoline		Fuel oil	
Gravity	61.0		14.0
IBP	86	Flash	310
10% off	120	Fire	420
20% off	149	Vis at 122°F.....	185
50% off	248	Pour	35
90% off	370	BS&W.....	0.3%
Maximum	402		
Color	10		
V.P. 10.5	lbs. Reid		
Octane .....72.			

Yields

Gasoline 42.93%
Fuel Oil 47.50%
Liquid recovery 90.43%
Gas & Loss 9.57%
Charge 100.00%

When handling reduced crude from the skimming plant fractionating column draw-off flange, the tower pressure, which averages about 6 pounds, gauge, is sufficient to pass the bottoms through the charge to bottoms exchanger, which reduces the temperature before the reduced crude pumps handle it. By following this method, it has been learned that the pumps and packing give greater service than if they were exposed to the higher temperature of the oil direct from the column.

Calculation of the Octane Number of Gasoline from Physical Data

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AN accurate, simple method for calculating the octane number of gasoline from such physical data as gravity, distillation data, and percent unsaturates is needed by small refiners who ordinarily must send samples of their gasoline, periodically, to large refiners who have equipment to run octane number. This service is usually costly and time taking, thus limiting the small refiner to infrequent checking of the anti-knock of his gasoline.

A calculation of this nature has until recently been hindered due to the lack of sufficient data on the octane number of pure hydrocarbons and a short, accurate method for analyzing gasoline. Recently a large quantity of data has been published by Lovell, Campbell and Boyd of General Motors Laboratory giving the anti-knock rating of all types of hydrocarbons.[1, 2, 3, 4] Also a better method for analyzing gasoline for its percent aromatics, naphthenes, aliphatics, and unsaturates has been developed by Schneider, Watkins and Stanton.[5] It can be seen that if the composition of a gasoline is known, the percent of each component in the gasoline could be multiplied by its blending value in octane number and the sum would be the octane number of the gasoline. In general this was the starting basis of the calculations given here.

Since the calculations are to be based on an average gasoline composition, some obvious objections will occur to the petroleum chemist. It can be seen that high or low percentages of branch chain compounds are not allowed for. However, present data of the authors indicate no appreciable variation in the ratio of branched compounds to unbranched except in the case of gasoline made by catalytic processes. Variations in the ratio between naphthenes and aromatics is partly allowed for in the calculation but wide variations would produce an appreciable error. For all such cases the method of calculation can still be used to obtain the correct octane number by adding at the end a constant correction obtained by noting the difference between experimental and calculated octane number on at least one sample of gasoline made from the unusual crude.

[1] W. G. Lovell, J. M. Campbell and T. A. Boyd. *Ind. Eng. Chem.* **23** (1931), 26.
[2] *Ibid.* **23** (1931), 555.
[3] *Ibid.* **25** (1933), 1107.
[4] *Ibid.* **26** (1934), 475.
[5] V. Schneider, A. E. Watkins and G. W. Stanton. To be published soon.

COMPILATION OF PRELIMINARY DATA AND DEVELOPMENT OF THE METHOD OF CALCULATION

The anti-knock data of Lovell, Campbell and Boyd, mentioned above, were given as aniline equivalent. In

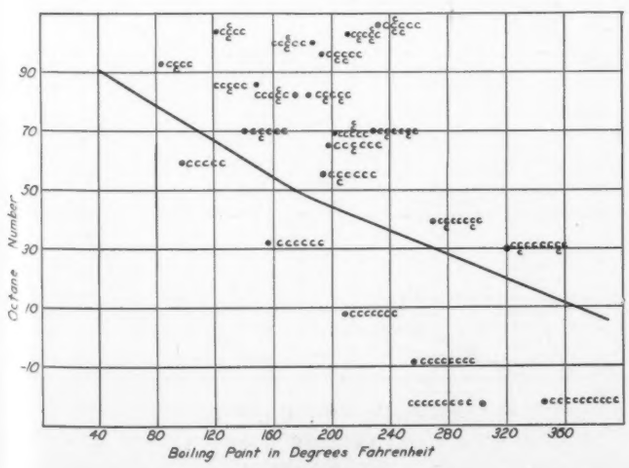


FIGURE 1
Anti-knock value paraffin hydrocarbons.

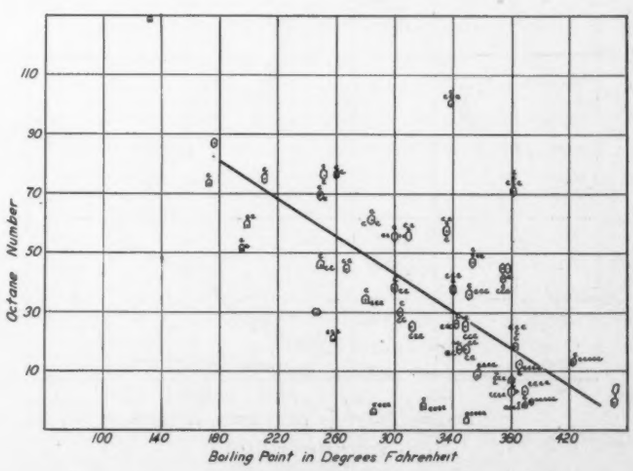


FIGURE 2
Anti-knock value of saturated naphthenic hydrocarbons.

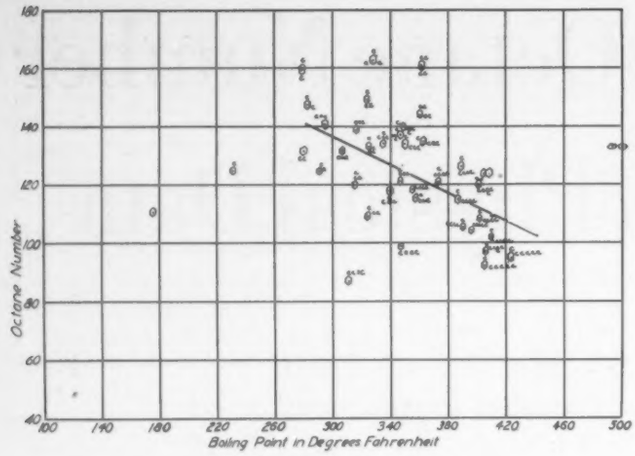


FIGURE 3
Anti-knock values of aromatic hydrocarbons.

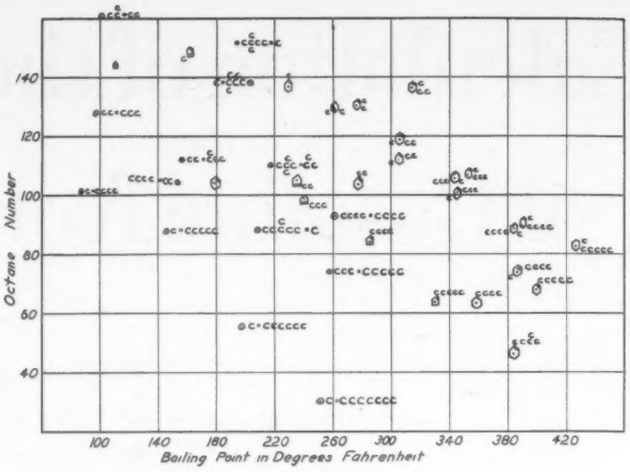


FIGURE 4
Anti-knock value of unsaturated hydrocarbons.

order to apply these values to the calculations, it was first necessary to change them to octane number. A formula as follows was devised for this change:

$$\text{Blending Value in O. N.} = \frac{1000 \times \text{An. Eq.} \times \text{Sp. Gr.}}{2 \text{ Mol. Wt.}} + 55$$

The octane number of each hydrocarbon was then plotted against its boiling point, the paraffin hydrocarbons on Figure 1, the naphthenic hydrocarbons on Figure 2, the aromatic hydrocarbons on Figure 3, and the unsaturated hydrocarbons on Figure 4. The curve drawn on each figure represents the approximate trend of each type with allowance made for the proportion of each compound as it occurs in gasoline.

The next step toward the calculation of octane number was to approximate as accurately as possible the average composition of the type gasoline to be used in the calculation. Since the composition of different grade gasolines varies and since the calcula-

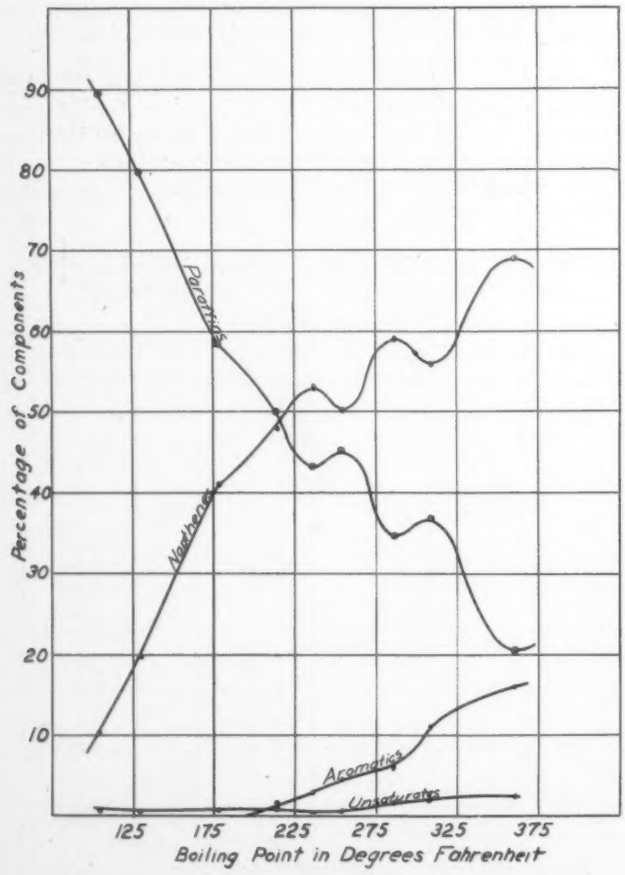


FIGURE 5
Average distribution of components in five fractioned, third-grade gasoline.

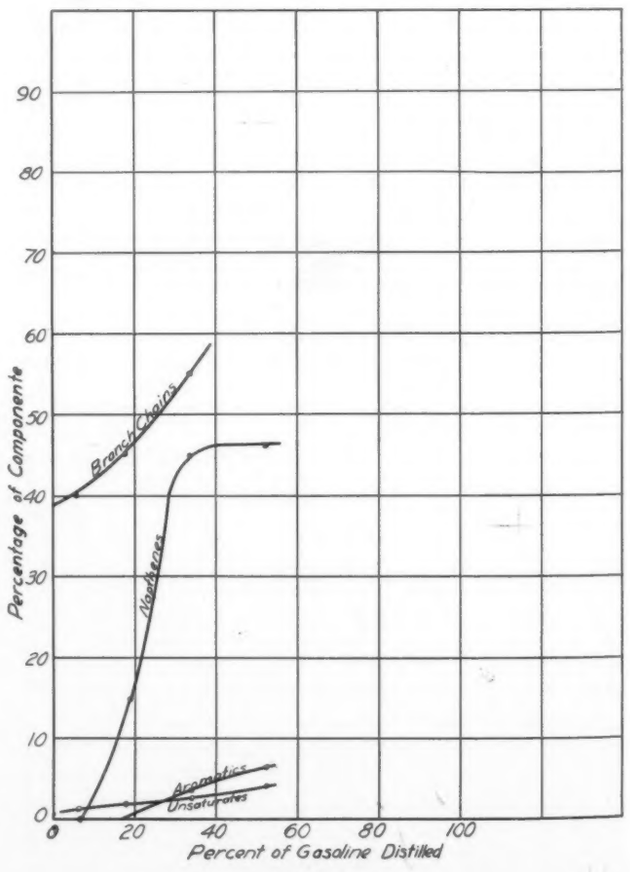


FIGURE 6
Percentage of various components in uncracked gasoline.

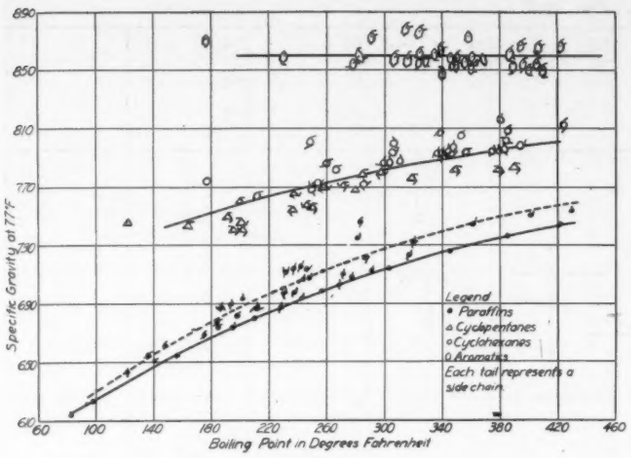


FIGURE 7

Specific gravity and boiling point of saturated hydrocarbons.

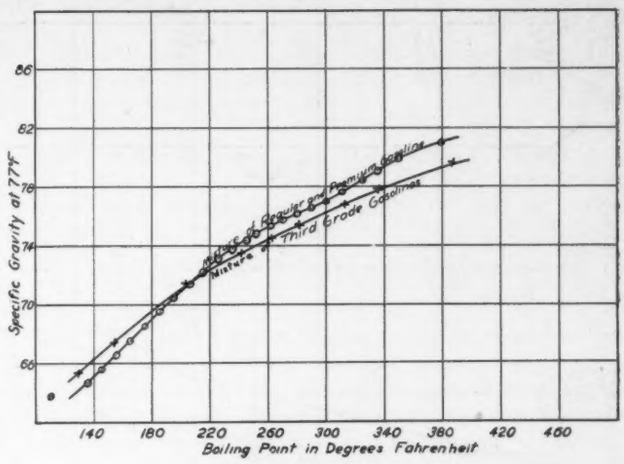


FIGURE 8

Gravity vs. boiling point for different grade gasolines.

tion probably would be more useful to small refiners producing third-grade gasoline, it was at first decided to limit the analysis to third-grade, uncracked or slightly cracked gasoline. It is interesting to note that the final method of calculation seems to apply fairly well to all grades of gasoline except, of course, those containing knock suppressors such as lead tetraethyl and those made by use of catalytic processes.

Using a method of analysis already mentioned,[5] the average distribution of aliphatics, naphthenes, aromatics, and unsaturates in each 10 percent cut of 5 fractionated third-grade gasolines was determined. These data plotted on Figure 5 show how the amount of each type of hydrocarbons varies with boiling point. These curves check very well with other data obtained previously by one of the authors from a carefully fractionated straight-run Pennsylvania gasoline. The latter data are plotted on Figure 6. Also some published data by Fenske, Quiggle and Tongberg[6] when used to calculate composition of their gasoline agree closely with the present data.

[6] M. R. Fenske, D. Quiggle and C. O. Tongberg. *Ind. Eng. Chem.*, **24** (1932), 542.

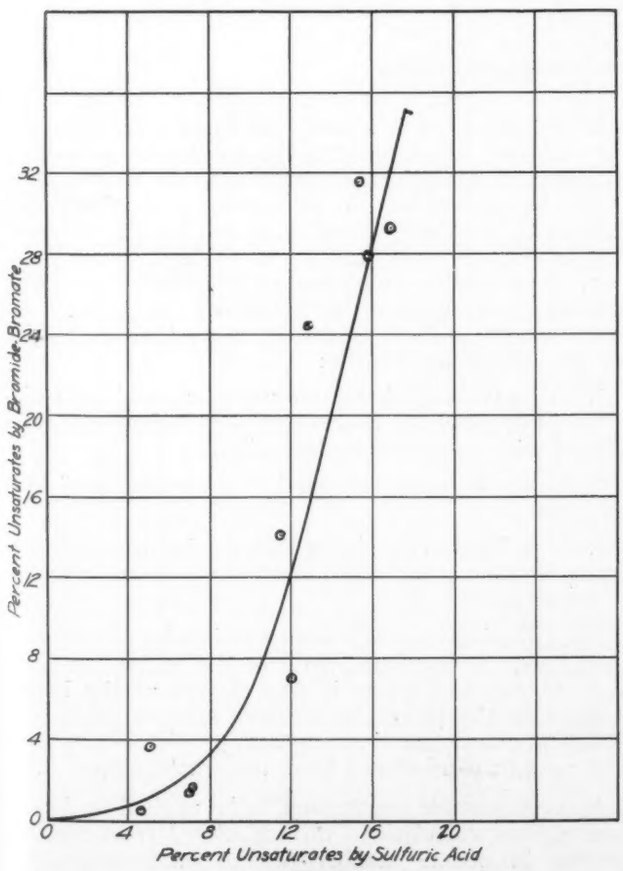


FIGURE 9

Comparison of sulfuric acid and bromide-bromate methods for obtaining unsaturates in gasoline.

By referring to Figure 5 it can be seen that the gasoline boiling below 120°F. may be considered as 100 percent aliphatics. The naphthenes then increase rapidly from this point. The aromatics appear appreciably about 220°F. The percent unsaturates is very low as it is in all uncracked gasoline.

By multiplying the fraction present of each class of hydrocarbons by their respective octane numbers for any one temperature and then adding, points were calculated for plotting octane number against boiling point of gasoline. This curve was modified slightly by use of data published by Fenske, Quiggle and Tongberg[6] which included anti-knock on each fraction. Errors in the curve were then found and corrected by a method described in a later paragraph. The final curve, octane number against boiling point, is given on Figure 11 and is used in obtaining the octane number of a gasoline.

The data on specific gravity of saturated hydrocarbons, Figure 7, show a wide difference in gravity between aliphatics, naphthenes and aromatics. Closer study shows the gravity of these three classes of hydrocarbons to be related very much the same as their octane numbers as shown on Figures 1, 2, 3, and 4. This suggests that corrections in octane number for variations in composition could be based on the gravity of a gasoline. Because of this proportion between gravity and octane number, such a correction would eliminate much of the error due to a change in ratio between aromatics and naphthenes.

The specific gravity of each 10 percent cut of a mixture of 5 different third-grade gasolines is plotted against its boiling point on Figure 8. Also a mixture of 5 different regular and premium grade gasolines

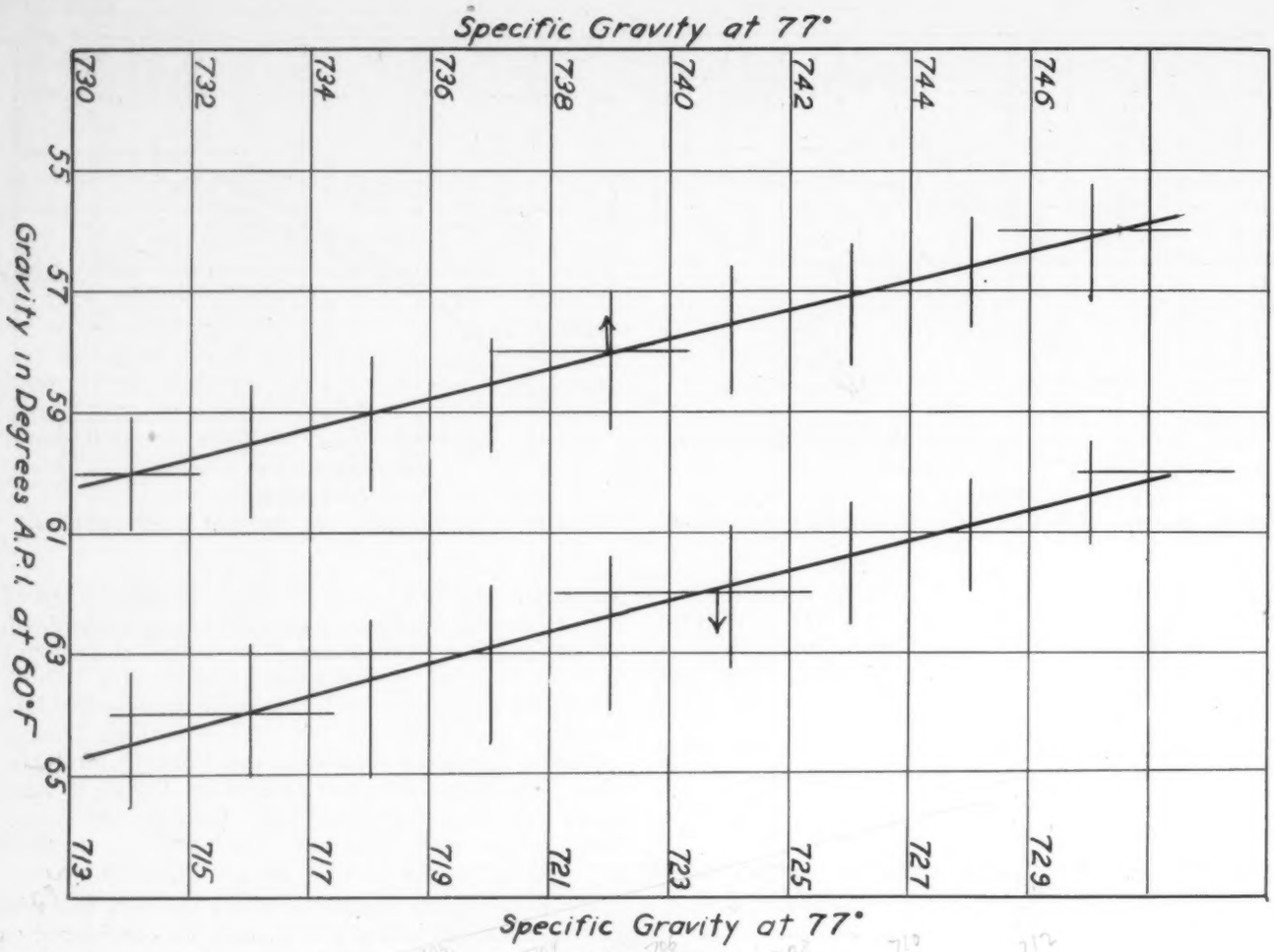


FIGURE 10

Relation between specific gravity and API gravity.

was distilled into 25 fractions and the specific gravity of each was determined and plotted as above on Figure 8. By use of these curves and the data given on Figure 7 in combination with the gasoline composition, it is possible to plot a curve, gravity against boiling point, in the same way that octane number was plotted against boiling point, Figure 11. But, as the average octane number and average gravity are similar functions of boiling point, it seemed probable that gravity could be plotted directly against octane number. By trial this was found to be true and since it shortened the method of calculation by about half, was so used. This curve, specific gravity against octane number, is plotted on Figure 12 and is used for finding the calculated gravity of the gasoline from the uncorrected octane number as read from curve, Figure 11.

If the calculated gravity as read from Figure 12 differs from the actual specific gravity of the gasoline, it means that the calculated octane number is in error due to the gasoline having a different percent aromatics and naphthenes than allowed for. A correction for this was calculated approximately and the best results were obtained using a correction of 0.3 on the octane number for every 0.001 difference in calculated and actual specific gravity. For example, if the calculated specific gravity is 0.004 lower than actual, a correction of 1.2 is added to the octane number.

[7] University of Texas Bulleting. No. 3543, Nov. 15, 1935, page 37.
[8] A. W. Francis. Ind. Eng. Chem., 18 (1926), 821.

As unsaturation is usually the largest factor causing variation in anti-knock, the calculation of octane number necessitates an accurate measure of unsaturation. The unsaturates in 10 gasolines of widely different unsaturation content were run both by absorption in sulfuric acid[7] and by bromide-bromate titration.[8] The results are plotted on Figure 9. This curve indicates one method is obviously in error. The sulfuric acid method seems the more inaccurate one for the following reasons:

1. Tests showed that some unsaturates do not dissolve 100 percent in concentrated sulfuric acid when diluted with saturated hydrocarbons.

2. Aromatics dissolve partly in concentrated sulfuric acid.

3. A molecule containing two double bonds is not given double value as this method gives only volume of unsaturates.

The bromide-bromate test gave results as accurate as the volume measurements in the limited number of tests run and hence it was chosen as the better method. If the particular sulfuric acid method mentioned above is used, a rough approximation to the true answer can be read from the curve, Figure 9.

A correction for unsaturates to be applied to the octane number calculations was calculated from the difference in octane number of the pure unsaturated hydrocarbons and the corresponding saturated hydrocarbons. An unsaturated hydrocarbon containing two

double bonds has approximately twice the effect on octane number as the corresponding compound containing one double bond. The increase in octane number due to unsaturation in every case for which data were available was averaged and the results gave 58 as the correction for 100 percent unsaturation. A corresponding correction for specific gravity was calculated by the same method and the results gave 0.0262 as the increase in specific gravity due to 100 percent unsaturation. This 0.0262 multiplied by the octane number correction due to gravity of 0.3 per 0.001 difference gives 7.86 octane number which will be accounted for by the gravity correction. This leaves about 50 octane number to be allowed for by a purely unsaturate correction. Correctness of this value of 50 octane number at various percentages of unsaturates was checked by the method described in the next paragraph and the curve on Figure 13 plotted to read total correction to be added to octane number for different percentages of unsaturates.

It seems worth while to describe the method used in attempting to find the factors which were causing errors in the earlier calculations. The calculation was made on about 20 gasolines and the error in octane number plotted against every conceivable variable such as percent over at 120° F., gravity of low-boiling fraction, gravity of high-boiling fraction, end point, percent unsaturates, octane number, etc. If a curve or general trend resulted, it showed that the error was a function of the factor it was plotted against and an effort was made to correct the error. In most cases no connection was found with the error and a scattered group of points resulted from the plot. In this manner the curves and corrections first developed from experimental data were modified to give better results.

METHOD OF CALCULATION OF OCTANE NUMBER

The actual calculation requires the use of only three curves as given on Figures 11, 12, and 13 and the application of two corrections, one for gravity and one for unsaturates. As the gravity of gasoline is ordinarily given in degrees A.P.I. at 60° F., a curve is included, Figure 10, for easy conversion to specific gravity at 77° F. Also, if the percent unsaturates is measured by absorption in sulfuric acid, it may be changed roughly to percent unsaturates by bromide-bromate titration by use of the curve on Figure 9. Now, given the A.S.T.M. distillation data, specific gravity, and percent unsaturates by bromide-bromate titration, the octane number of a gasoline may be calculated as follows:

1. From Figure 11, the octane number of the first 5 percent is read at the initial boiling point and the value as read from the curve multiplied by 0.5 since the values on the curve are for 10 percent of the total. The next 10 percent is read at the 10 percent boiling point and multiplied by 1 plus 0.1 the distillation loss. (This assumes the distillation loss has a boiling point approximately the same as the 10 percent boiling point.) The next 10 percent is read at the 20 percent

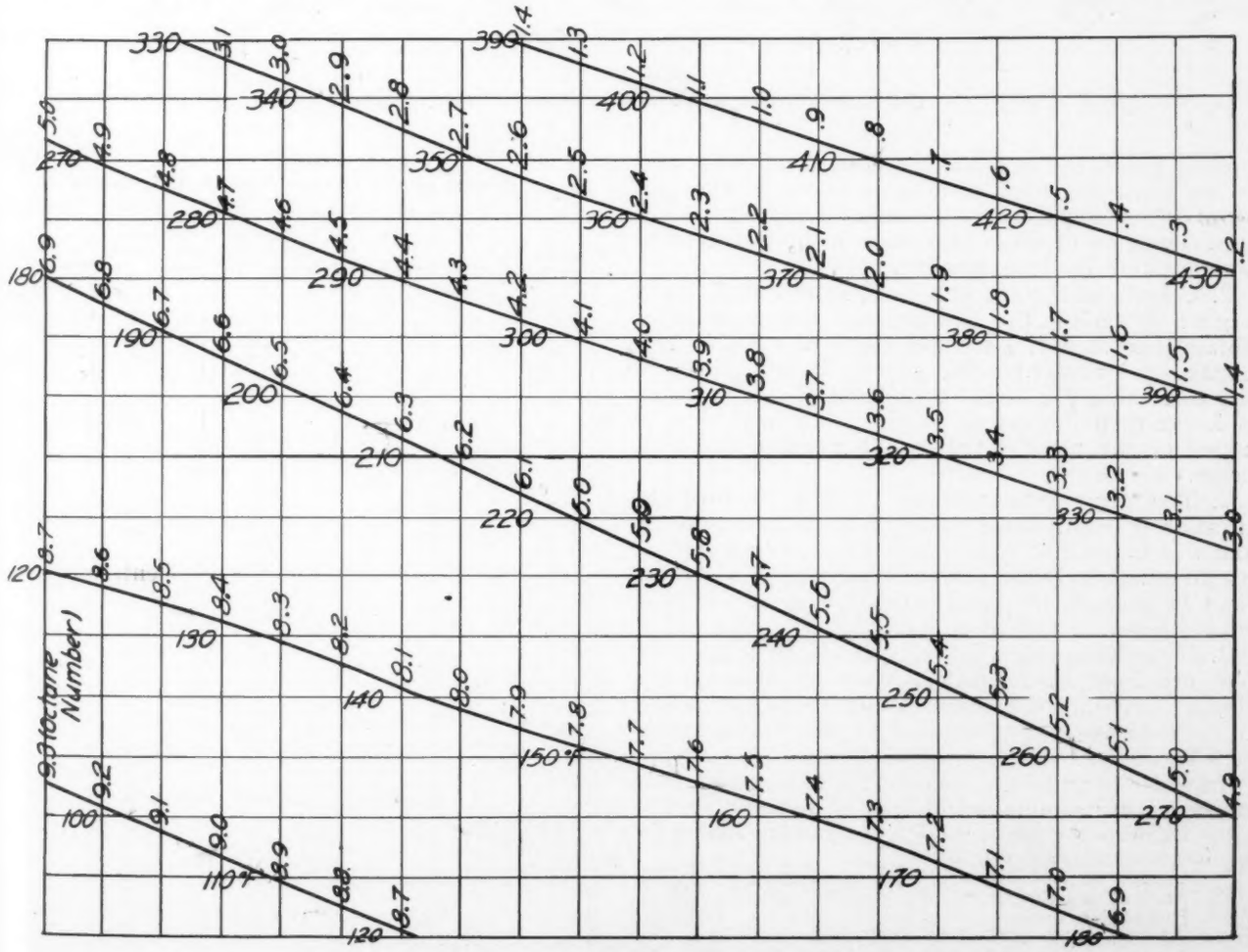


FIGURE 11

Boiling point in degrees Fahrenheit vs. octane number for each 10 percent fraction.

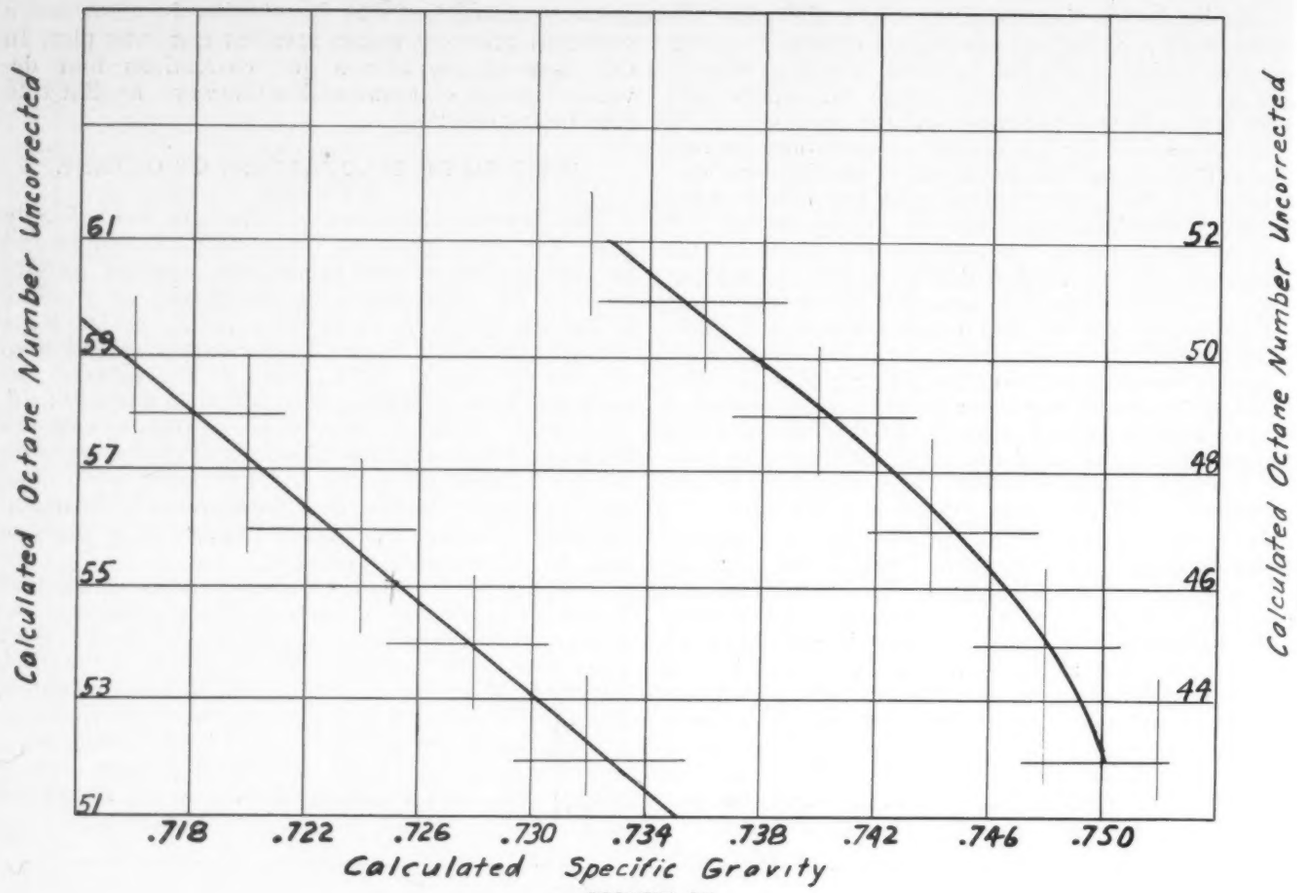


FIGURE 12

Calculated octane number vs. calculated specific gravity.

boiling point, the next at the 30 percent point, and so on until the final reading is taken at the end point and multiplied by 0.5 minus 0.1 the distillation loss. The sum of these 11 values is the uncorrected octane number of the gasoline.

2. Calculated specific gravity is read directly from Figure 12 using the uncorrected octane number obtained in step 1. Each difference of 0.001 in calculated and actual specific gravity is multiplied by the correction 0.3. If the calculated specific gravity is lower than the actual gravity, this correction is added to the uncorrected octane number and vice versa.

3. The percent unsaturates by bromide-bromate titration is multiplied by 0.5 if less than 14 percent and this correction is also added to the uncorrected octane number. If the percent unsaturates is greater than 14 percent, the total correction to be added is read directly from Figure 13.

4. If the calculation is being made on a gasoline obtained from an unusual crude, a constant correction as determined experimentally should be added to the final value of octane number as obtained from step 3.

In order to make the steps in the calculation clear the following sample calculation is given:

Calculate the octane number of a gasoline having the following physical properties:

Gravity = 59.1 degrees A.P.I. at 60° F.

Percent unsaturates = 2.0 percent by sulfuric acid.

Distillation data—

I.B.P.	10%	20%	30%	40%	50%	60%	70%	80%
108	153	182	207	228	248	270	296	329
		90%	E.P.		Loss			
		362	404		1.3			

TABLE 1

Results of the Octane Number Calculation

Gasoline No.*	Actual Octane No.	Calculated Octane No.	Error
1	57	55.04	— 1.96
2	57	61.58	+ 4.58
3	63	61.30	— 1.70
4	49	51.17	+ 2.17
5	49	49.83	+ 0.83
6	55	57.25	+ 2.25
7	55	53.18	— 1.82
8	56	58.11	+ 2.11
9	63	59.90	— 3.10
10	63	61.30	— 1.70
26	61	61.25	+ 0.25
27	54	53.42	— 0.58
28	61	61.80	+ 0.80
43	56	59.07	+ 3.07
11	56	54.56	— 1.44
12	61	60.31	— 0.69
13	59	59.84	+ 0.84
14	55	54.21	— 0.79
15	64	66.47	+ 2.47
16	54	52.93	— 1.07
17	54	56.72	— 7.28
18	55	53.71	— 1.29
19	58	57.79	— 0.21
20	64	59.76	— 4.24
21	55	56.76	+ 1.76
22	56	55.08	— 0.92
23	57	59.24	+ 2.24
24	56	56.63	— 0.63
29	56	61.81	+ 5.81
30	46	44.54	— 1.44
31	47	47.75	+ 0.75
32	54	61.72	+ 7.72
33	48	51.41	+ 3.41
34	49	50.91	+ 1.91
35	46	44.20	— 1.80
36	58	61.61	+ 3.61
37	47	47.97	+ 0.97
38	55	52.28	— 2.72
40	51	62.98	+11.98
41	45	45.95	+ 0.95
42	53	51.15	— 1.86
44	49	52.03	+ 3.03

* Gasoline numbers are the same as those used in the Texas University Bulletin [9].

From Figure 10, A.P.I. is changed to specific gravity = 0.7348.

From Figure 9, the unsaturates are converted to bromide-bromate basis = 0.4 percent.

From Figure 11, the octane number for each ten percent is read, five percent is read at the initial boiling point and the end point, the loss is added to the ten percent point and subtracted from the last five percent:

8.96×0.5	= 4.48	
7.65×1.13	= 8.65	
	6.85	
	6.30	
	5.85	
	5.40	
	4.92	
	4.22	
	3.29	
	2.30	
$1.00 \times .37$	= 0.37	
Uncorrected octane number	52.63	
Actual gravity	0.7348	
Calculated gravity	0.7311	(Read from Figure 12)
Difference	0.0037	
Correction per 0.001	0.3	
Total gravity correction	1.11	(To be added)

Unsaturate correction = $0.5 \times 0.4 = 0.2$

Calculated octane number = $52.63 + 1.31 = 53.94$

[9] The data used in making these calculations were taken from *University of Texas Bulletin* No. 3543, Nov. 15, 1935.

ACCURACY OF METHOD

The octane number of every third-grade gasoline for which data were availble[9] was calculated by the above described method. The results are given in Table 1.

It can be seen that the results, with few exceptions, are within 3 octane numbers of the values determined by the standard method (that is, in the A.S.T.M.-C.F.R. Motor). In a few cases there were obvious misprints in distillation data and these with other undetectable errors in data would make it probable that a few calculations of octane number would not check the experimental values given. Also the percent unsaturates given were measured by absorption in concentrated sulfuric acid and it can be seen by reference to Figure 9 that this alone may introduce an error of as much as 4 octane numbers for a cracked gasoline.

Due to the theoretical soundness of the calculation, it is certain that if sufficient care is taken in obtaining the data to be used, the method will give as accurate results as is desired when applied to the type gasoline for which the calculation was devised. In any case the application of an experimentally determined correction will bring the results within the limits of accuracy usually allowed in the determination of octane number.

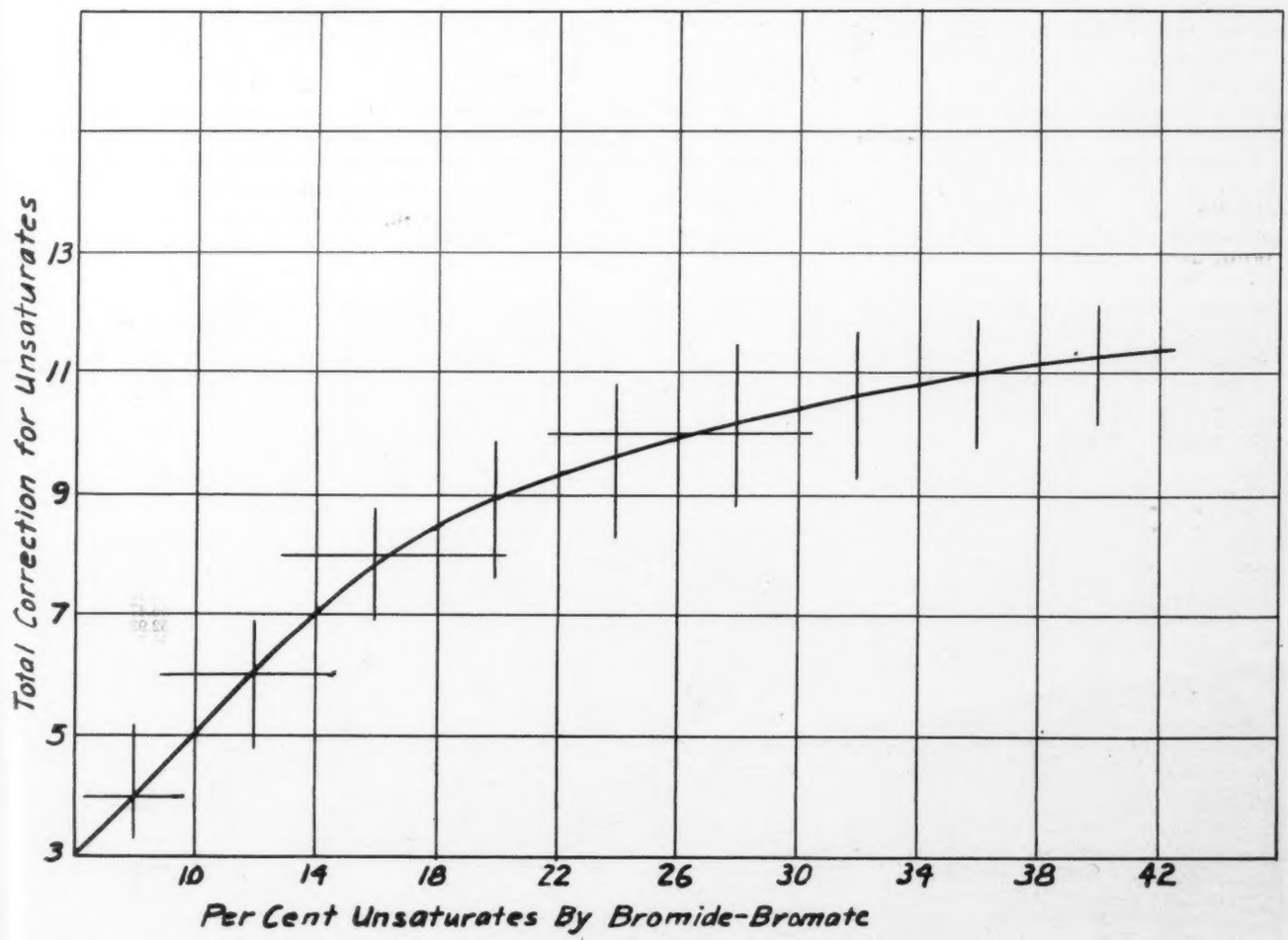


FIGURE 13

Unsaturate correction for high percentages.

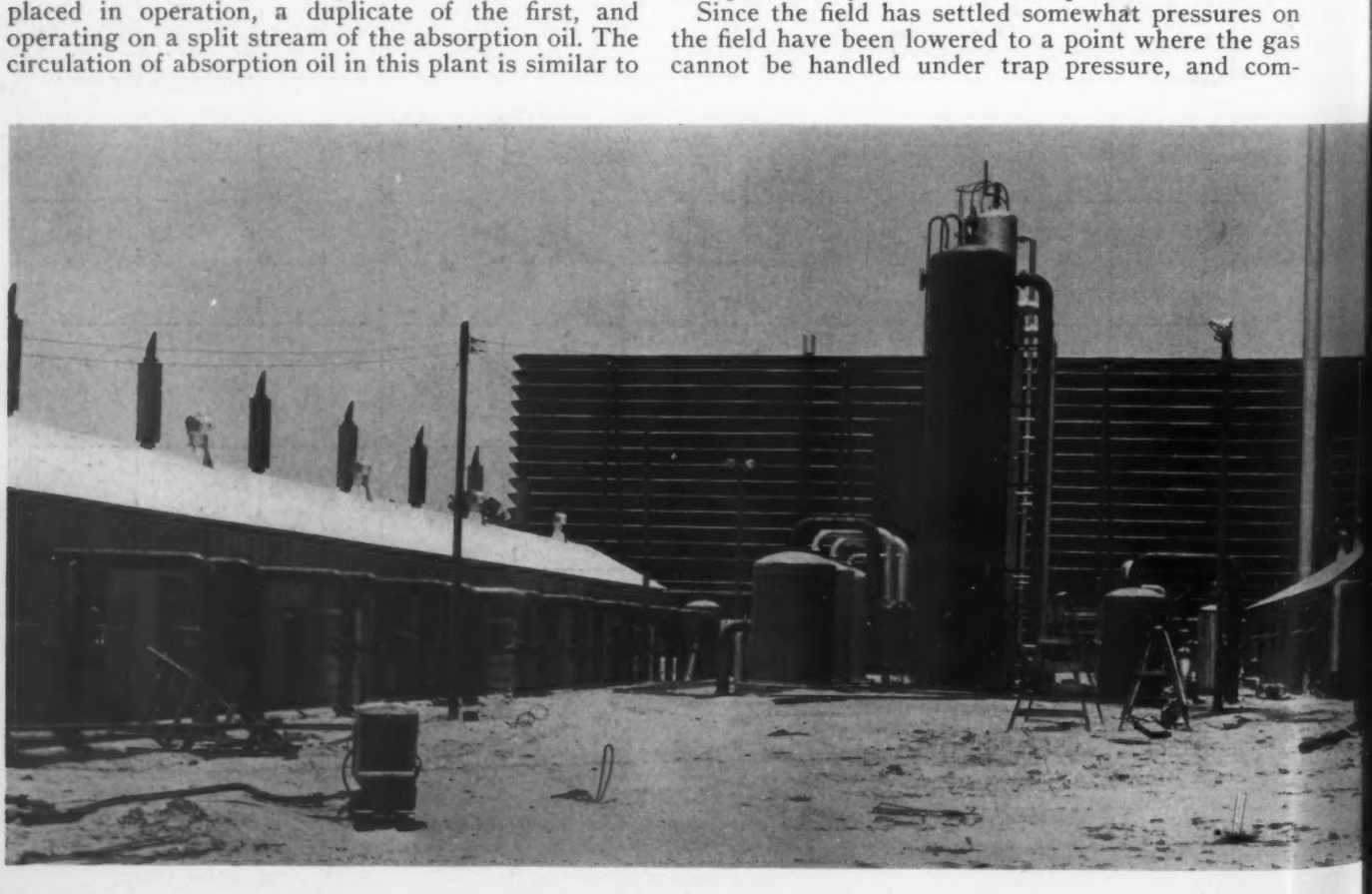
Direct Fired Heaters *Employed in* Rodessa Gasoline Plant

EXTENSION of Rodessa oil field into Miller County, Arkansas, and subsequent development in the latter part of 1937 and early 1938 assured sufficient gas from separators and low-pressure traps to justify construction of a natural gasoline plant in the area. Obtaining sufficient contracts to cover the supplies of gas, East Texas Refining Company constructed the first part of a plant in the early part of 1938, and found it necessary to increase the size of the plant in the summer of the same year.

The plant is operated on two separate pressures—one from low-pressure separators handling oil and gas from low gravity oil wells, and the other on gas produced from so-called distillate wells, having flowing pressures exceeding that which is normally maintained on ordinary traps and separators. To take care of this situation, two sets of absorbers are operated, but requiring only one distillation apparatus, and one stabilizer. The original design is capable of processing approximately 100,000,000 cubic feet of gas, and the addition will handle considerably more, depending upon the production requirements in the field and conservation orders from the state.

A large portion of the plant is laid out along conventional lines, but includes direct-fired heaters instead of the usual steam-distillation units. Only one direct-fired heater was operated in the original set-up, but while increasing the capacity, a second unit was placed in operation, a duplicate of the first, and operating on a split stream of the absorption oil. The circulation of absorption oil in this plant is similar to others operating as absorption plants, but requiring two sets of pumps; one for high pressure and the other for low pressure. High-pressure oil strips the gas in one system, but is reduced in pressure at a flash drum to release unstable vapors, which enter the low pressure system for reabsorption and selection.

Since the field has settled somewhat pressures on the field have been lowered to a point where the gas cannot be handled under trap pressure, and com-



pressors were recently installed to move a portion of the gas at low pressure. Six-angle type gas engine-driven compressors were running the latter part of June, and facilities were at hand for setting four additional machines as conditions advance in the field. The rebuilding of the plant, while requiring work to be done against operating equipment did not interfere with production of gasoline, as all new units were set before tieing into current lines.

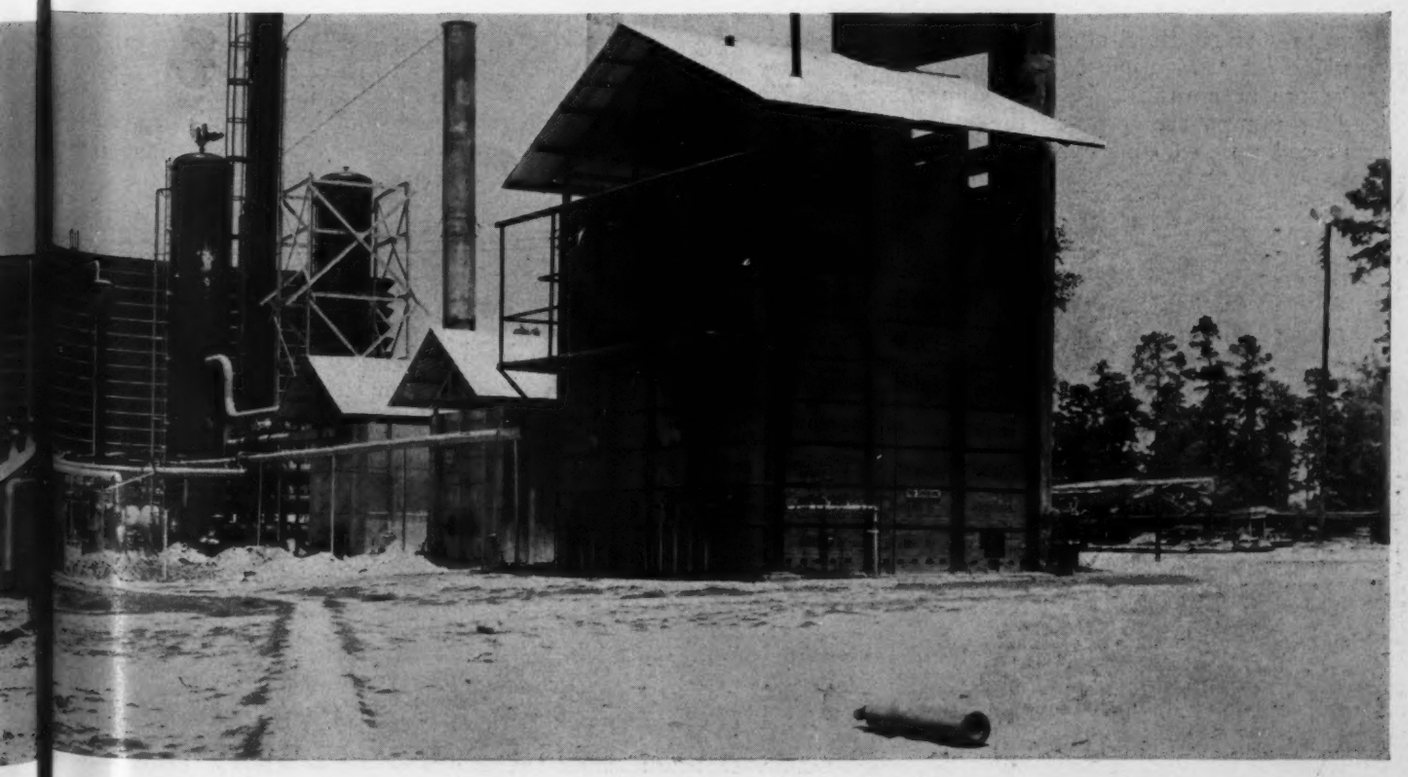
The engine room was designed to take suction on existing field lines and to discharge into the common header leading to the low-pressure system. Intake and suction piping is laid in the usual manner, having control gates installed on short stub lines connected to the headers at required intervals. After headers were installed, each engine as it was set up and tested for running, was cut into the system without the necessity of waiting for all engines to be installed. Future engines are to be placed in operation in the same manner, without interruption of operating procedure or the necessity of tying into live lines with a welding torch or screwed fittings.

In order to obtain desired working temperatures in gas-cooling apparatus, oil cooling and condensing of gasoline and reflux, the extension of the plant capacity required additional water cooling, and to obtain this feature, the louvre tower was doubled in size. Water is circulated over this unit with two turbine-driven centrifugal pumps, both installed in shallow concrete-walled pit near the water basin to eliminate long suction and discharge lines. Taking advantage of high-pressure gas which is processed in the plant at a pressure much higher than utilities and the field fuel systems require, the turbines are fitted for gas instead of steam. Boiler capacity is reduced by this means and energy is conserved. Instead of reducing the residue pressure from the high-pressure absorbers through the conventional type of regulator or control valves, the turbines perform this duty. Gang pumps are installed on the turbines, so that water may be pumped over the top of the louvre tower, and part of it directed through shell-and-tube units for other cooling purposes.

Both the low-pressure and the high-pressure absorption oil (after the high-pressure absorbing medium is vented to release the lower boiling fractions), are combined in a common stream to flow through the heat exchangers to pick up temperature in the neighborhood of 300° F. From these units, the combined streams of oil flow to the two tube-still heaters to acquire process temperature, which is about 360° F. From the outlet of these heaters, the oil passes to a combination steam still and flashing tower, where the natural gasoline fractions are released from the oil with the assistance of process steam. This vessel is 6 feet in diameter and has a height of 45 feet, and is operated under a pressure of about 40 pounds, gauge. Top temperature is controlled to a point where the gasoline vapors are of end-point grade, preventing the carry-over of absorption oil. Vapors leaving the still are partially condensed and both liquid and uncondensed gases are separated from steam condensate, with final cooling of product occurring in subsequent coolers. Reflux for end-point control is pumped from the final condensate accumulator to the top of the fractionating still by close-clearance gasoline pumps operated by temperature-control instruments.

Lean oil from the flashing steam-still flows through the rich oil exchanger and through atmospheric coolers to a surge tank from which it is picked up at a temperature as low as can be obtained with water cooling by two pumps, the first a centrifugal unit that delivers the oil to the low-pressure absorbing

East Texas Refining Company's Miller County, Arkansas, gasoline plant. Compression plant, scrubbers and absorbers with main pump house are shown at left. At right is shown water tube boilers, two direct fired heaters with fractionating equipment adjacent to the cooling tower.



Interior of pump house, East Texas Refining Company gasoline plant in Miller County, Arkansas, extension of Rodessa field.

system, and the second, a reciprocating unit for high-pressure service to the high-pressure absorbing units. The exchanger on the lean oil reduces the temperature of the lean oil to about 140° F. before it enters the atmospheric sections for final cooling.

Gasoline as it is condensed is removed from the accumulator tank by close-clearance pumps and transferred at the rate of production to the stabilizer. This is a column 3½ feet in diameter and 70 feet high. For a 26/70 natural, the column is operated at 190 pounds, gauge, pressure and with a reboiler temperature of 260° F. Overhead condensate is produced in atmospheric sections, and is accumulated in a 3½-foot diameter vessel and pumped in required volumes to maintain fractionator temperature and product quality. Stabilized material flows at process pressure through charge-to-product exchangers, and is cooled to required temperature in atmospheric units as it flows to storage. Steel storage for 250,000 gallons is provided for production, from which it is loaded into tank cars at a rack 2½ miles from the plant. No loading pumps are used as the storage tanks are pressured up to 30 pounds, which, together with a substantial gravity fall is sufficient to load cars in required time.

Steam is generated for plant use in reciprocating and turbine-driven pumps by 2 400-horsepower water-tube boilers. The boiler setting is more or less conventional as to fire-brick insulation, but the surrounding steel structure is all-welded with longitudinal and vertical beams securely attached to each other to prevent creep and warping of walls. The outer surface of the setting consists of common brick, laid from the top downward, resting upon steel girders and separated from the inner fire-brick wall by a dead air space of about 2 inches.

Water is produced for plant requirements from deep wells on the property, which are operated with gas lift. The water required for engine jacket cooling is carried in a closed system, held in reserve by a steel tank installed near the engine room, from which it flows by gravity over the units. Air cleaners are required in this area, as the surface of the ground consists of fine sandy loam, lifting easily with every breeze. It is highly abrasive and if allowed to enter the power cylinders, would quickly demand a reconditioning job on the engines.

Six, four-cylinder angle type gas engine-driven compressors in compression plant.

Polymerization, Cracking *and* Gasoline Extraction

at Shamrock Plants

J. C. ALBRIGHT

TO utilize butanes produced in its natural gasoline plant, located on the North Plains of the Texas Panhandle, northeast of Dumas, Moore County, and to process overhead products from a pressure-distillate stabilizer which is a part of a Dubbs cracking unit, Shamrock Oil & Gas Corporation operates a U. O. P. Catalytic Polymerization plant. The plant was designed by Universal Oil Products Company, and was constructed by Stearns-Rogers Manufacturing Company, under the general supervision of Parkhill-Wade, Inc. This plant is the first of the type to be built which uses butanes for charging stock in combination with cracked refinery products, charged in the first step as a cold liquid, at the rate of 1,100 barrels daily.

The type feed fed to the polymerization plant, taken from the charge tank is shown as follows:

POLYMERIZATION PLANT CHARGE TANK

	Percent
Methane	00.00
Ethylene	00.00
Ethane	00.00
Propylene	00.00
Propane	00.00
I-Butylene	.38
Butylenes	1.35
Butanes	98.27
Total	100.00

To obtain the major portion of the polymerization-plant charging stock, gasoline manufactured from Moore County sour gas is processed through a primary fractionator to produce required grades of commercial gasoline, and to separate all butane not necessary for bottom product. In most instances, the gasoline manufactured is 12-pound RVP, with butane and lower boiling fractions passing from column overhead and condensed for secondary fractionation. In the second column, the bottom product is commercially pure butane, with propane and lighter vented from the reflux accumulator tank for fuel and other purposes. In the first stage of fractionation, all uncondensed vapors from the absorption plant are compressed through five 300-horsepower gas engine-driven compressors cooled and condensed, and fed to the stabilizer to recover higher-boiling fractions than butane, while passing those lighter vapors through the fractionator for secondary processing. A part of the feed to the polymerization plant consists of pressure-distillate overhead condensate, which is blended with natural butanes at the plant charge tank. In this tank also is the recycle material,

fractions of polymerization-process gas that are not converted either in the dehydrogenation cracking furnace, or the catalytic columns, and, upon being separated from the finished catalytic-polymer gasoline, re-enters the charge tank as recycle stock. This material has the following fractional analysis:

RECYCLE STOCK

	Percent
Methane	00.00
Ethylene	00.00
Ethane	00.00
Propylene	00.00
Propane	.72
I-Butylene	.57
Butylenes	2.04
Butanes	96.67
Total	100.00

Two vessels at the inlet of the feed tank contain caustic solution to remove sulphur compounds, which are alternately, with a three-inch line entering equipped with a cast-iron jet elbow, followed by cast-iron mixing nozzles for intimate contact between the product and the chemical. Both flow into 4 x 12 feet vessels for separation with the mixture entering the upper side of the vessel at one end, and the product flowing out at the opposite end, also from the upper side. The feed then enters a 10-foot-6-inch x 40-foot horizontal work tank, constructed with 15/16-inch walls, sufficiently large to contain charging stock for some time, to prevent the polymerization plant being shut down if fresh feed is not produced for a short period.

The temperature of the feed tank is usually about 86°F. during summer months, and the material at that temperature is picked up with a 3¼ x 18-inch steam pump and discharged without passing through heat exchangers at a pressure of about 700 pounds, gauge, to the inlet of the butane-cracking or dehydrogenation furnace. The furnace is similar in design to the conventional crude oil cracking furnace, with tubes arranged in size and placing to provide adequate heating. The unit is fired from the bottom, with up-shot burners, and contains a center wall, with products of combustion leaving through breeching to a self-supported stack erected on a concrete pad beside the furnace. This heater contains a total of 116 tubes which are 30 feet long, 64 of which are 3½-inch O.D. x 2¾-inch I.D., used for heating the charge. The remaining 52 tubes, 5-inch O.D. x 4-inch I.D. are arranged in the heater for soaking. Temperatures obtained in the cross-over tube from cracking to soaking bank is about 1038°F., and the material in the 4-inch transfer line has a temperature of about 1048°F. with a pressure of about 692 pounds, pressure drop through the unit being almost negligible.

In this step, approximately 50 percent of the butanes contained in the charge are converted. The material then passes through subsequent process reboilers to supply heat, instead of steam or side-cut from cracking plant fractionating column, and is immediately liquefied, accumulated in a receiving drum and flows to the demethanizing column through a pressure-control valve. This column is 3 x 40 feet, contains 19 cast-iron bubble trays, and has a shell thickness of 11/16-inch, with the product entering at desired points, usually above the sixth bubble tray at about 308 pounds pressure. As the very lowest boiling fractions contained in the converted charge are to be removed, the temperature of the reboiler is carried at 150°F., and the overhead, or vapor outlet maintained at 88°F. with reflux from subsequently separated materials, consisting of pyrolytic polymers from the next, or debutanizing column. Separated products leaving the demethanizer are treated as uncondensible gases, and passed to fuel lines or other means of utilization. This material shows the following by fractional analysis:

DEMETHANIZER OVERHEAD

	Percent
Methane	78.22
Ethylene	6.54
Ethane	10.61
Propylene	1.18
Propane	1.34
I-Butylene	.08
Butylenes	.24
Butanes	1.79
Total	100.00

With unsuitable materials fractionated from the product, the demethanizer base material is fed direct under process pressure to the debutanizer, a column 4 feet-6 inches x 40 feet, equipped with 19 cast-iron bubble trays, and which is operated at 270 pounds, gauge. Temperature on the base of this column is maintained by heat obtained from the material leaving the furnace before cooling, and is carried at 440°F. to vaporize those fractions required for catalytic polymerization. Overhead temperatures are maintained at 200°F. to remove heavy products, such as pyrolytic-polymer gasoline, that are withdrawn as a liquid from the base of the column. A part of the pyrolytic-polymer gasoline is pumped, at a rate of 525 gallons per hour, to the top of the demethanizer to act both as reflux and as an absorption liquid, which controls to a large extent the efficiency of fractionation in this column. The pyrolytic-polymer gasoline has the following distillation:

PYROLYTIC POLYMER STREAM

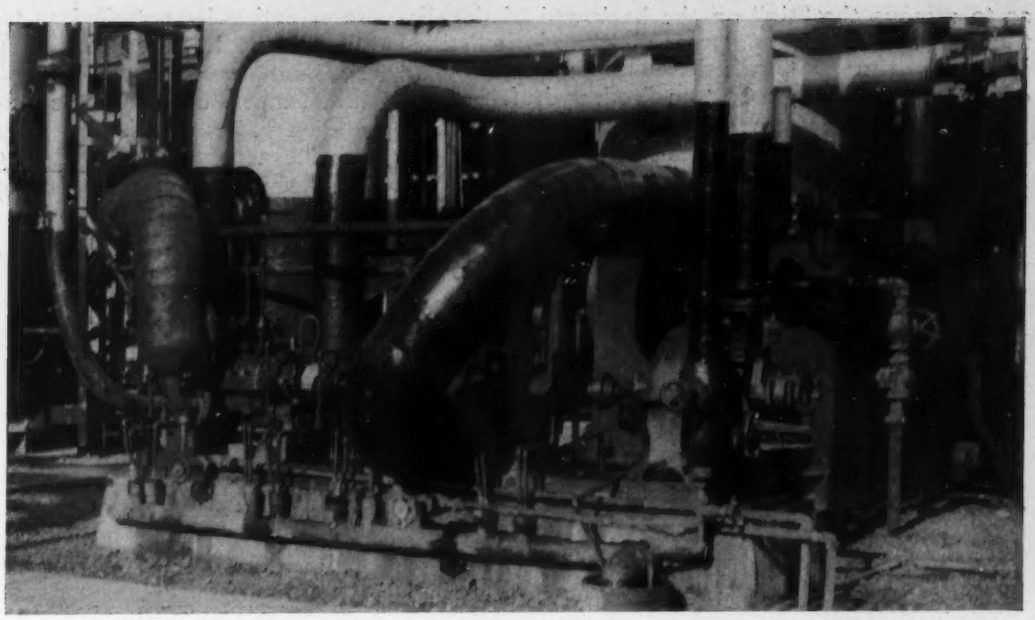
A. P. I. Gravity	51.0°
I. B. P.	120°F.
10 Percent	150°F.
20 Percent	164°F.
30 Percent	178°F.
40 Percent	190°F.
50 Percent	204°F.
60 Percent	228°F.
70 Percent	258°F.
80 Percent	320°F.
89 Percent	400°F.
92 Percent	437°F.
RVP	5.0 lbs.
Sulphur	.025 Percent
Octane Number	78.0

Overhead from the debutanizing column is condensed in required amounts to be used as reflux, with the excess material flowing as gas to the catalytic-polymerization product gas heater. A fractional analysis of the debutanizer overhead material shows the following:

PROCESS GAS

	Percent
Methane	00.00
Ethylene	2.09
Ethane	8.14
Propylene	14.82
Propane	10.86
I-Butylene	1.15
Butylenes	1.92
Butanes	61.02
Totals	100.00

The above material is passed to the process gas heater to increase temperatures to that at which the catalytic towers operate satisfactorily. The heater is



Gang pump hook-up where centrifugal pumps driven by a steam turbine are handling poly material to stripping columns prior to polymerization.

a smaller unit than the pyrolytic furnace, but is constructed on the same principle; having burners in the floor with up-draft, and containing banks of tubes for imparting necessary heat to the process gas. The temperature required is about 445° F. on the outlet, and the pressure maintained is about 250 pounds, gauge. The furnace contains a small bank of tubes to heat water for processing, which is added to the stream at the furnace inlet (about .55 percent based on process gas charge) to control to a certain extent the catalytic reaction in the polymerization columns.

There are four catalytic towers arranged as closely to each other as operating conditions will permit and manifolded so that the flow is downward through three towers in series. The manifold is constructed with adequate control valves and connecting piping so that any of the towers may be removed from service without hindering the operation of those remaining. The operation usually includes three colums, with the fourth being reactivated. The number on stream, however, depends upon the efficiency of individual units, which is determined largely by the pressure drop through it, increase of which indicates that the granular catalyst is becoming contaminated. The towers are installed on a sub-structure of steel and concrete, sufficiently high above the ground level that removal of spent catalyst may be easily accomplished through manholes in the base. They are also equipped with a super-structure to handle fresh catalyst when filling from the top.

The product flowing from the last catalytic column in the series is contacted with a certain percentage of water to reduce corrosive influence, which together with condensed water vapor introduced at the inlet of the catalytic furnace is separated in a receiver. The product is condensed in suitable units and accumulated for pumping to the depropanizer to remove unsuitable light materials. These are passed to fuel lines or other means of disposition. The depropanizer column is 3.5 x 37 feet, equipped with 19 cast-iron bubble decks and finished with 2-inch insulation, with feed entering the column above the twelfth deck. The tower is operated at 310 pounds, gauge, with a reboiler temperature of 170° F., and a top temperature of 109° F., which is controlled by reflux pumped back over the column with a ratio of 4.3:1. Overhead gases removed have the following fractional composition:

DEPROPANIZER OVERHEAD STREAM

	Percent
Methane	4.56
Ethylene	2.96
Ethane	36.80
Propylene	10.59
Propane	45.13
I-Butylene and heavier	00.00
Total	100.00

The base product from the depropanizing column is passed to the stabilizer so separation may be accomplished between raw catalytic-polymer gasoline, and unsuitable fractions which are not stable at normal temperatures and at atmospheric pressures. The stabilizer is 3.5 x 34 feet, containing 15 bubble decks, and is operated at a pressure of 108 pounds, gauge. The reboiler temperature is maintained at 282° F., by pumping material through the pyrolytic furnace transfer line exchangers to obtain this temperature. Overhead temperature is held at 106° F. with overhead condensate, pumped under positive control; excess condensate is pumped back to the plant feed tank. The raw catalytic-polymer gasoline has the following distillation:

CATALYTIC POLYMER STREAM

A. P. I. Gravity, 60° F.	65.4°
RVP.	8 Lbs.
IBP.	100° F.
10 percent	140° F.
20 percent	170° F.
30 percent	190° F.
40 percent	208° F.
50 percent	224° F.
60 percent	240° F.
70 percent	260° F.
80 percent	290° F.
90 percent	336° F.
95 percent	390° F.
End Point	440° F.
Flask Recovery	97.5%
Color	Blue
Gums, Copper Dish	190.0 mgs.
Gums, A. S. T. M.	24.0 mgs.
Oxygen Bomb Induction Period	120 min.
Sulphur	.015%
Octane Number	86.5

To remove objectionable gums, to improve oxygen bomb induction period, and to improve color, as well

as to remove the "tip" on the back end of the distillation, the catalytic polymer gasoline is redistilled in the re-run unit, which contains conventional equipment, including a bottom-fired, updraft furnace, fractionating columns and condensers. After the catalytic-polymer gasoline has been rerun, the Engler distillation shows the following:

RERUN CATALYTIC-POLYMER GASOLINE

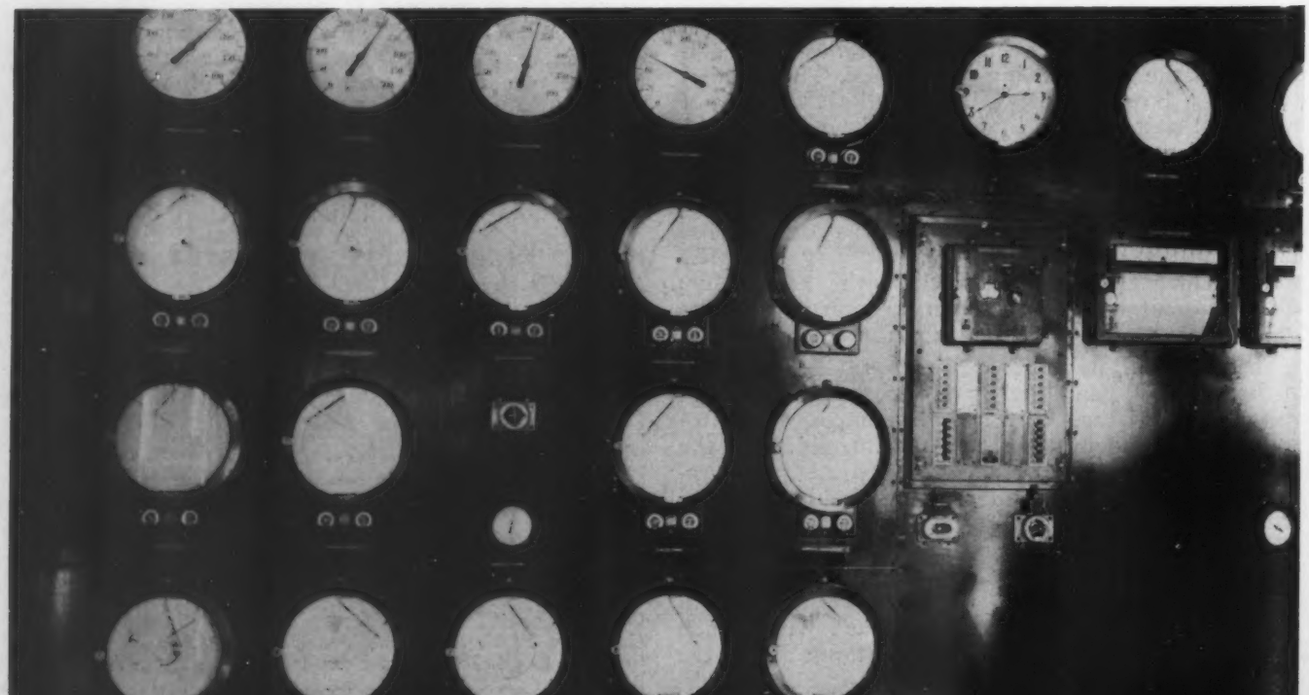
A. P. I. Gravity	66.0°
I. B. P.	98° F.
10 percent	142° F.
20 percent	170° F.
30 percent	188° F.
40 percent	204° F.
50 percent	220° F.
60 percent	234° F.
70 percent	258° F.
80 percent	290° F.
90 percent	334° F.
95 percent	372° F.
End Point	398° F.
Flask Recovery	97.5%
Reid Vapor Pressure	8 Lbs.
Color	+30
Gums, Copper Dish	7.0 mgs.
Gums, A. S. T. M.	0.0 mgs.
Oxygen Bomb Induction Period	330 min.
Sulphur	.01%
Octane Number	86.3

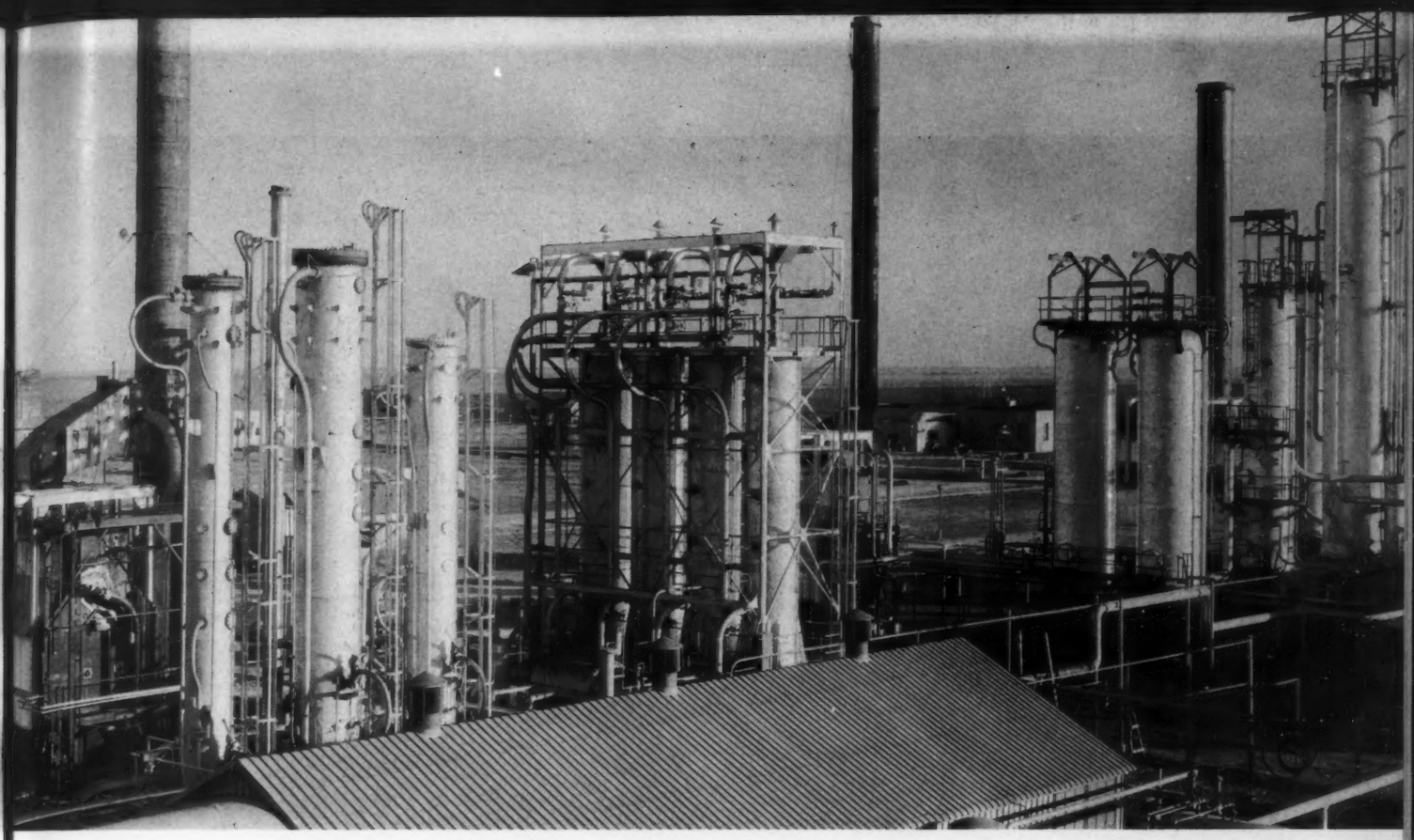
In order that the catalyst towers may be maintained in efficient working condition, each one is regenerated occasionally, the time intervals being determined by the efficiency of the catalysis and the pressure drop through individual towers. The column is removed from service by closing and opening proper manifold valves, and manufactured flue gas is passed through the bed of catalyst. Each tower is equipped with an external jacket, to pass heated air, or flue gas through the annular space for controlled heating while regenerating. The gas prepared for regeneration is controlled as to its oxygen content so that removal of the deposits on the granular catalyst shall not proceed beyond a certain rate, or beyond a definite temperature within the column. The time of regeneration varies and is dependent upon the amount of service a particular bed has given. After a column has been regenerated, it is rehydrated and connected with the manifold for another run.

Yields of this plant depend upon the characteristics of plant feed, and the percentage of conversion of paraffinic hydrocarbons to unsaturates. An average conversion is said to be approximately 40 percent of the fresh feed in the pyrolytic furnace, with from 4 to 5 percent pyrolytic-polymer gasoline recovered from the base of the debutanizing column. Through the catalyst towers, the material is passed as a gas, with yields of about 4.00 gallons per thousand cubic feet processed recovered from the base of the final stabilizer as raw catalytic polymer gasoline.

So that positive control may be obtained through all processes and steps of polymerizing, each unit is equipped with modern instrument controls. The pump and control room has a number of pumps for charging and to maintain reflux rates, with an instrument board fitted with controlled-recorders and indicating pyrometers. This building, like others in this plant, is equipped with an air conditioning and heating unit, as well as fire-fighting equipment, including steam smothering lines which are controlled at remote points. Reboiler circulating pumps are placed outside the building and are operated with a steam turbine, to which the pumps are connected in gang, each performing its definite duties as to volumes of reboiler material handled to pyrolytic furnace transfer exchangers.

Control board in the catalytic polymerization plant.





Close-up of the McKee plant cracking and polymerization process area.

Cracking Plant

WHEN Shamrock Oil & Gas Corporation expanded its refining facilities a completely new 2500-barrel plant was constructed to take the place of an outmoded skimming plant. The new installation is a Dubbs cracking plant erected by Arthur G. McKee & Company.

Sour crude oil produced from company wells in the field surrounding the plant, or topped crude from the company's older skimming plant at Meldavis, near Lefors, in Gray County, is used for the cracking plant charging stock, alternating each material throughout a normal run.

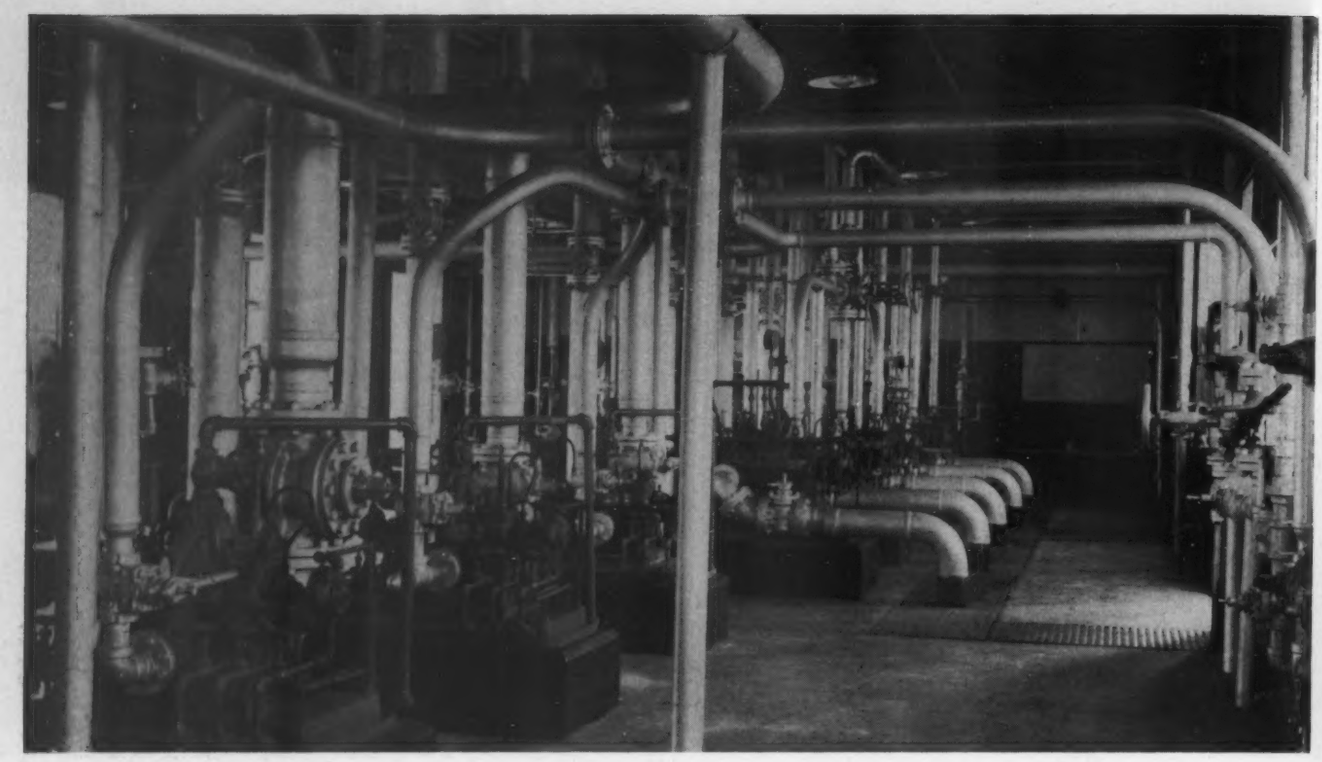
The topped crude from the Gray County skimming plant is received in tank cars, and averages 25.2° API, has an initial boiling point of 440° F. with approximately 5 percent distilled over at 570° F. in laboratory apparatus. The crude produced in Moore County has an average API gravity of 35.5°, an initial boiling point of 152° F., with 21.5 percent distilled over at 400° F. BS&W in the crude averages less than .2 percent, but salt is found with an average running from 200 to 400 pounds per 1000 barrels, most of which is removed in a heating and settling system before it enters the main processing system.

The charge is picked up from working storage with a 100-gallon-per-minute steam turbine-driven centrifugal pump and passed through a 3-inch charging line to the pressure distillate precooler, or exchanger, where the charge is heated to 280° F., flowing immediately to the salt settler. This vessel is 6 feet across and 30 feet long, having a shell thickness of ⅞ inch and working at 200 pounds pressure, gauge. As the crude passes through this chamber, baffles and the time of passage permits from 40 to 65 percent of the salt to be settled out.

The charge next enters the main fractionating column, which is 8 feet, 6 sixes across by 61 feet high, equipped with 16 cast iron bubble decks and 8 cast iron side-to-side pans, entering above the second side-to-side pan from the top of this section. Process pressure is at 60 pounds, gauge, and the temperature at this point is 600° F. An outer coat of 2 inches of insulation is applied to the upper section, and 3 inches applied to the lower section.

The combined feed is removed from the base of the fractionating column at 667° F. with a 6½ x 18-inch outside plunger packed pump, driven by a steam engine directly connected to the unit. The amount of oil, including recycle, that is handled by this pump is about 6800 barrels per day, varying with the amount of fresh charge introduced to the column.

From the heavy oil pump, the hot charge enters an up-shot furnace having two rows of burners, one on each side of the center bridge-wall. The stream is split in two equal parts at the furnace inlet, and passes through the heater in two identical sets of tubes varying from 3¼-inch O.D. and 2¼-inch I.D.

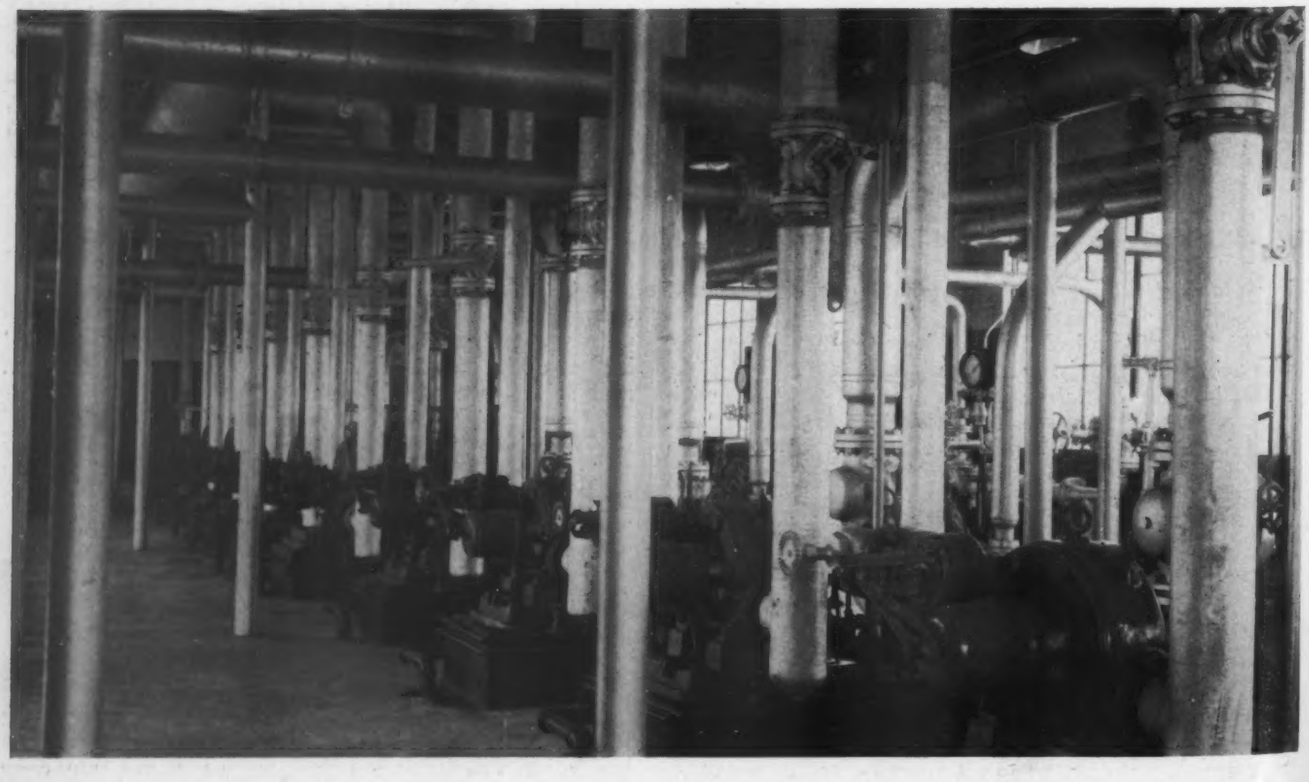


Control and pump house at the cracking plant, showing centrifugal pump installation, piping and manifolding arrangement.

to 3¼-inch O.D. and 2½-inch I.D. All tubes are 35 feet long and there are 128 tubes in the heater, which are equipped with forged-steel tube headers. Inlet pressure is maintained at 500 pounds, gauge, with the transfer line pressure at 225 pounds, and the material leaving the furnace has a temperature of 935° F.

The reaction chamber has a diameter of 5 feet, 6 inches and a height of 40 feet, fabricated with walls 3 inches thick and covered with 5 inches of insulation. It is equipped with the customary inlet nozzles at the upper end and wall washing connections through which the charge flows together with a controlled amount of cooling oil to control the re-

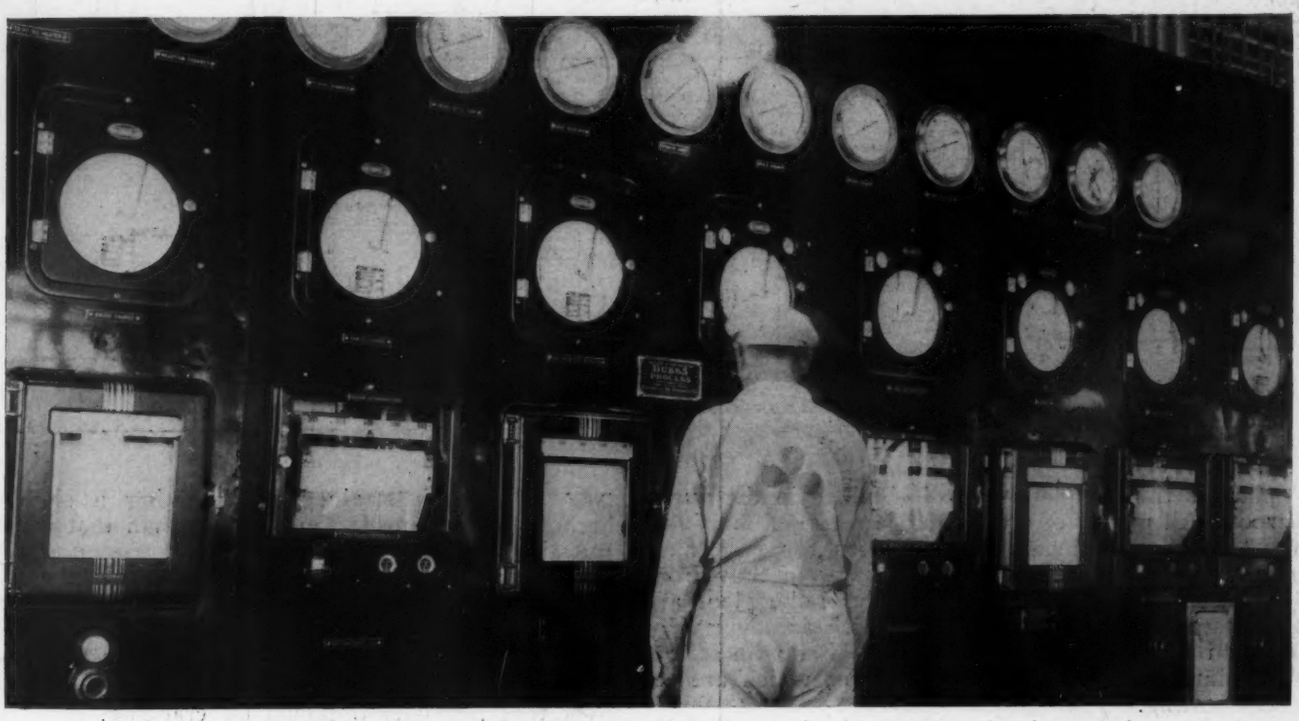
Control and pump house at cracking unit, showing turbine-driven centrifugal pumps and arrangement of auxiliary equipment.



action occurring within the chamber. The top temperature of the chamber is usually around 895° F., and a pressure is maintained at 225 pounds, gauge.

From the reaction chamber, the material flows through the pressure-controlling valve and the nipple where cracking is arrested with low-pressure cooling oil, part of which may have been used for reboiler heating and a part may be composed of polymer gasoline from the catalytic plant. The flash chamber into which the material passes from the reaction chamber has a diameter of 8 feet, 6 inches and a height of 35 feet, fabricated with 15/16-inch wall sheets having an external application of 3 inches of insulation. Bottoms in this vessel are fuel-oil residuum, having an API gravity of 10.6°, a Cleveland open cup flashing point of 245° F., a fire point of 355° F., a pour test of 40° F., Furol viscosity of 90 at 122° F. It is pumped from the chamber with a 9 x 5 x 10-inch duplex steam pump to the residuum is picked up by a centrifugal pump, with a capacity of 245 gallons per minute for overhead temperature control as main column reflux.

The sub-cooled distillate is withdrawn from this vessel with a 16 x 8 x 18-inch steam-driven pump to the debutanizer exchanger and pumped to the debutanizer column. This vessel has a diameter of 4 feet, and a height of 55 feet 9 inches with ¾-inch walls and is equipped with 30 cast iron bubble decks. The exterior surface of this column is covered with 2-inch layer of insulation. The charge may enter the debutanizer column at any of four different nozzles, as provisions are made at the fifteenth, seventeenth, nineteenth and twenty-first decks for entrance of the feed. The column is operated at a pressure of 200 pounds with the reboiler temperature maintained at 400° F. The reflux is pumped to the column at 104° F. with an 8 x 7 x 18-inch simplex, close-clearance steam pump.



Operator in control room observing operation of Dubbs cracking plant when coming on stream.

cooler. This is made of 54 20-foot lengths of 3-inch pipe placed in a cooling box through which cold water is pumped.

Vapors from the flash chamber are removed at a pressure of 60 pounds, gauge, through a 10-inch vapor line to the base of the main fractionating column where they enter below the side-to-side pans. To control the quality of the product removed from the top of the column, the top temperature is maintained at 380° F. At this temperature the vapors pass through the vapor-to-charge exchanger and to coolers and condensers. The pressure distillate flows with the uncondensed gases to the pressure distillate receiver, a drum 5 feet 6 inches in diameter and 10 feet long, which is operated at 58 pounds pressure. An average volume of gas, equal to about 640,000 cubic feet is taken from this vessel, with the liquid flowing through a sub-cooler to a second drum, 5 feet by 10 feet with ⅜-inch walls, from which it

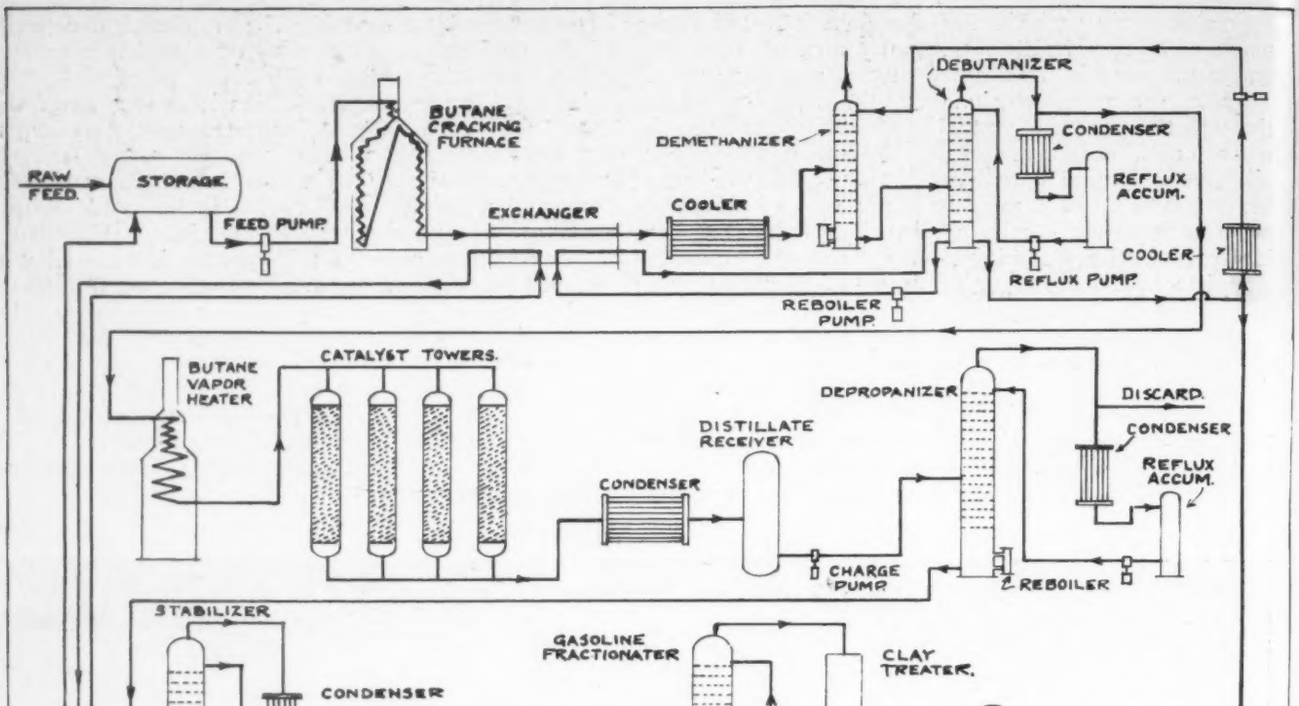
Production of 1800 barrels of pressure distillate daily represents a yield of 72 percent; 518 barrels of residuum, 19.98 percent and a loss of 8.02 percent. The pressure distillate is further treated in liquid phase through clay towers, and may, or may not be re-run through an auxiliary furnace and fractionating columns, depending upon the characteristics of the product and the quality required.

The characteristics of the pressure distillates are as follows:

PRESSURE DISTILLATE

	Moore County Crude Oil	Gray County Topped Crude
Gravity	58.4° A.P.I.	57.0° A.P.I.
IBP.	108° F.	108° F.
10%	154° F.	152° F.
50%	270° F.	266° F.
90%	370° F.	376° F.
EP.	400° F.	402° F.
RVP.	5.8 lbs.	5.0 lbs.
Octane number	62.0	67.0

One of the interesting features of the cracking



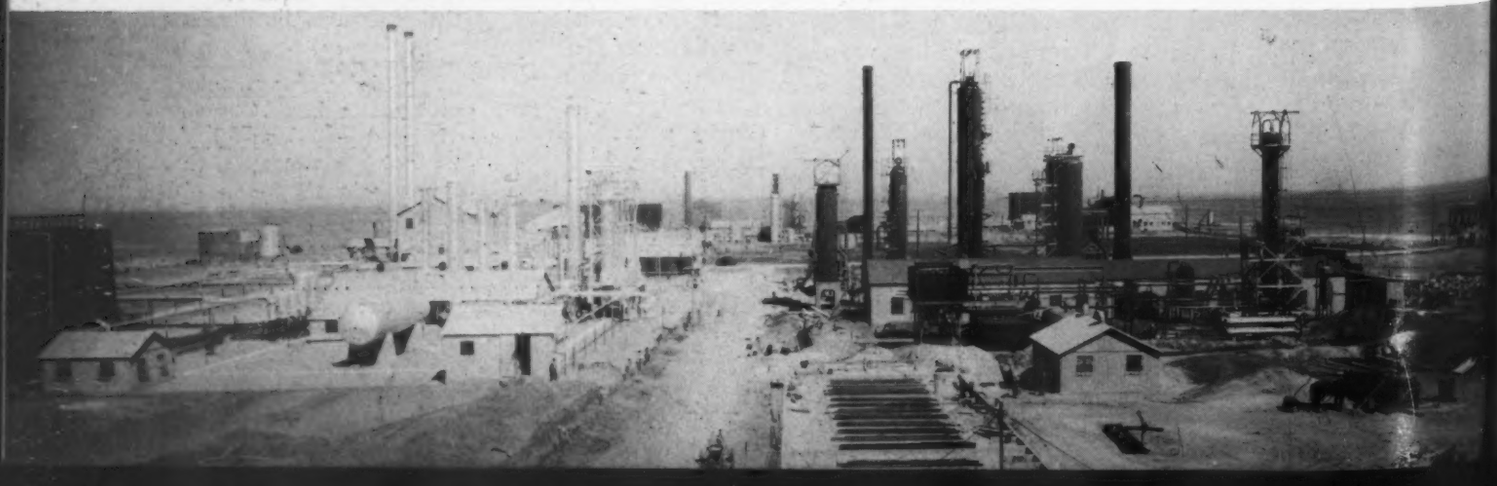
SIMPLIFIED FLOW DIAGRAM – POLYMERIZATION UNIT.
THE SHAMROCK OIL & GAS CORP., MOORE COUNTY, TEXAS.

plant is the complete control obtained in the pump room. All phases of operation are recorded and indicated by instruments with devices for governing pump speeds, temperatures and rates of flow from one central point. Pumps throughout the plant are operated with steam, most of which are driven by steam turbines, with the exception of column reflux, residuum and hot oil charge pumps, which are reciprocating.

Another feature is the ease and promptness by which fires may be extinguished, should one occur within the pump room or other buildings. A single remote controlled plug valve, equipped with segement and steel cable may be instantly opened to cause complete flooding of buildings with live steam in large quantities. In addition to this equipment, the buildings are air conditioned, having motor-driven fans which draw fresh air from outside, and pass it through strainers, maintaining a slightly higher pressure inside the building than that which prevails outside.

An interesting occurrence in cracking is the rise in octane number of pressure distillate when polymer gasoline is used in the quenching oil. It is stated that with only a few hundred gallons used daily, the octane rating can be raised two or three points over that normally obtained by cracking.

If rerunning is required to reduce the end point "tip," the distillate is passed through clay in the liquid phase. Final treatment consists of pumping the material through contactors with chemicals, employing caustic washes and doctor solution. It is then blended with catalytic-polymer gasoline, natural gasoline, and blended with "Q" fluid in certain instances.



Gasoline Plant

WHEN both sweet and sour natural gas were discovered in Moore County several years ago, Shamrock Oil & Gas Corporation erected an extraction plant to operate on well pressure. Due to further discoveries of oil and gas the plant was enlarged three times. Recently all units were re-arranged for more economical operation. The maximum capacity is about 250,000,000 feet of gas, which is processed under two pressures, one from "dry" gas wells, and the other on gas from separators at oil wells.

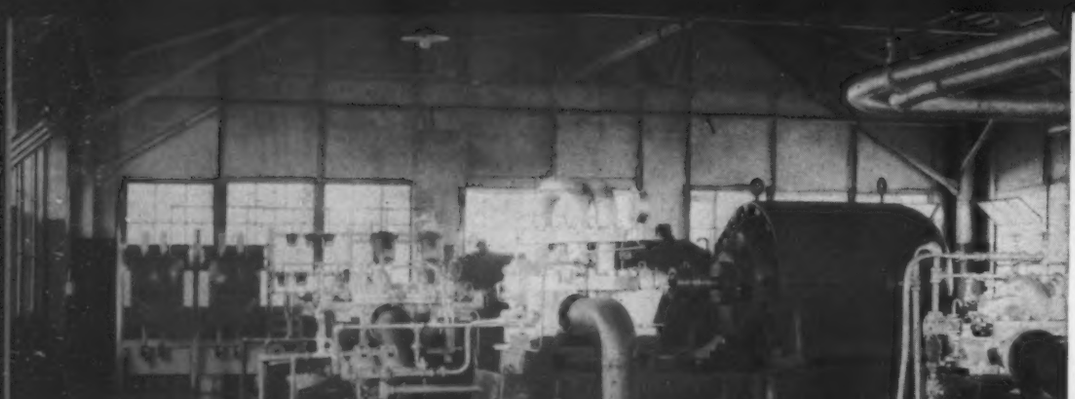
Features are found in this plant which are not common to the majority of natural gasoline plants, among which is the type of cooling towers. These are designed to operate under controlled conditions inducing their own draft from velocity of descending sprays from overhead distributor pipes. Another feature is the elaborate system of drop-out connections and fire-fighting facilities, the former arranged in such a manner that all material in process, including gasoline, absorption oil and gas may be diverted from the plant and dumped into a main line leading to the plant discard gas flare.

Five absorbers are operated, all of which are designed for comparatively high-pressure work, around 300 pounds, gauge. They are arranged with by-pass headers and connections so that any number may be used for high-pressure gas, or, on low-pressure separator gas. Under ordinary working conditions in this part of the Panhandle, the so-called "dry" sour gas predominates. This gas has a gasoline content of less than one half gallon, which makes it possible to use four of the five columns on this material. As sour gas alone is processed for its natural gasoline fraction, the residue is disposed of to several carbon black plants in the vicinity, a smelter a short distance to the west and a new electric generating plant erected to supply power for the Moore County oil fields and gasoline plants.

Double fractionation is practiced in this plant. The first step is operated for manufacturing any commercial grade of natural gasoline required, and the second for manufacturing cuts from the first stabilizer overhead discard that may include a mixture of butane and propane, or a propane-free product which is later processed in a catalytic-polymerization plant. Overhead from the second fractionator, condensed under pressure and lowered temperatures, is used in part for refrigeration and finally as fuel. The plant was designed by Parkhill-Wade, Inc., and erected by Stearns-Rogers Manufacturing Company.

Gas is measured with orifice meters at wells throughout the district, and again measured through master meters as it enters the plant. Conventional

Five angle type, 300-horsepower gas engine-driven compressors in natural gasoline plant, handling gases from vent tanks for recompression.



Multistage centrifugal pump driven by 300-horsepower electric motor in natural gasoline plant operation.

meter runs are employed when measuring the gas from the field and the residue when it passes from the outlet of the absorbers. As the gas from wells and separators in the field is never warm (averaging 65-70° F.) it is not necessary to pass it through cooling sections to reduce the temperature.

The high-pressure absorption towers are operated at an average of 280 pounds, gauge, and the low-pressure columns at 90 to 100 pounds. Oil circulation averages about 32 gallons of oil to each 1000 cubic feet of gas in the low-pressure system, and is varied in quantity through the high-pressure columns to extract more or less of the low-boiling fractions, particularly the butanes. The oil used for circulation is manufactured in the Dubbs cracking plant, operated on the same site.

Mist extractors are installed in the upper ends of the absorbers to eliminate the carry-over of absorption oil, and after-scrubbers are installed to prevent liquids from accidentally passing with the residue gas to the carbon black plants.

The oil from absorbers flows from the outlet level controllers to heat exchangers, preheaters, dewatering tanks and two distillation columns. Temperatures on the rich oil to the exchangers vary over a narrow range, usually about 83° F. on the inlet of the first exchangers, where the oil is heated to an average of 260 to 265° F. at the inlet of the preheaters. A fractionating rich oil vent tank is used to remove some of the more volatile fractions, such as propane and some of the butanes, so that the stills may not be overcrowded. The oil is further heated to 336° F. in the preheater before it enters the distillation apparatus. Two stills are used, both of which are operated at a pressure of 45 pounds, gauge, with the top temperature carried at 234° F. to control end point of distillate.

Oil leaving the still flows backward through the exchangers, and is reduced to 145° F. on the outlet, thence to cooling sections in the down-draft towers where the temperature is reduced to 85° F. Pumps for handling the absorption oil are of the centrifugal type, powered by both steam turbines and electric motors. High-pressure oil is handled by multi-stage pumps, operated with 300-horsepower 2200-volt motors, and the low-pressure oil by steam-turbine-driven single-stage pumps.

Condensed gasoline is received in a common accumulator, from which it is pumped as manufactured to the primary fractionator to either stabilize the material, or reduce it to a practically butane-free product. The operation of this column may be varied to suit conditions. When producing a 12-pound Reid vapor pressure material, it is carried at a pressure of 200 pounds, gauge, and with a bottom temperature of 304° F., with the top refluxed to obtain a temperature of 130° F.

The 5-unit compressor station, designed to handle a varying volume of gas, depending upon the intake and discharge pressures, receives the gas from the vent tank and the dewatering tank, all of which is uncondensed in the processes, taking suction at 26 pounds, gauge, and compressing it to 255 pounds, gauge. The building in which the engines are placed is equipped with apparatus to filter dust from air delivered to the room, heating it at the same time when necessary, and distributing it through an overhead duct. This scheme is essential to satisfactory and economical operation of gas engines in this section of the country, due to plowed fields which blow

Interior of gasoline plant control and pump house with explosion proof electric motors driving centrifugal transfer pumps. Control board in background.

during high winds. The equipment for air conditioning the engine room is set in a separate building, containing the filters, circulating fans and heaters. The product of compression is composed principally of butane and propane, but to recover higher-boiling fractions, the condensate is processed through the primary, or first fractionator.

Overhead condensate from the first fractionator is condensed in its entirety, and pumped to the second column for removal of propane and other low-boiling fractions not desired. The column is operated at pressures varying to suit conditions, but when manufacturing commercial butane, free from propane and lighter, the pressure observed is about 250 pounds, the reboiler temperature at 226° F., and the top, refluxed with overhead condensate is carried at about 116° F. In order to accelerate condensation of compressor product, the excess propane and lighter fractions condensed in the secondary fractionator are passed to the compressor room and expanded in shell-and-tube units to reduce temperatures of the gas after it has passed through the atmospheric cooling sections. The temperature on the compressed gas is 75° F. entering the expander coolers, and leaves these sections at 65° F.

The method followed in dumping vessels of liquids and gases includes a remote-control station where ends of wire lines are attached to handle pulls, with the cables passing through underground conduit, or they are attached to levers located at the same point. Dump valves are attached to each vessel with lead lines connected to the valve outlet and to a common disposal conduit, which leads to the plant flare. Each of these drop-out valves is equipped with a sheave upon which is wound the steel cable, wrapped a sufficient number of times to insure complete opening of the valve when it is desired to clean out the vessel. All hand-pulls at the remote control station are equipped with stenciled labels so that operators may know instantly which cable to pull, if conditions do not require all equipment to be emptied.

Each building in the gasoline plant is equipped with steam snuff lines to smother flames with quantities of water vapor. The snuff lines circle the inside of the building, and are supported by roof trusses, placed near the walls. At regular intervals, 8 feet apart, nipples are welded to the snuff lines that extend outward and downward at an angle of 45 degrees, with the outer end of each nipple shaped to produce a flaring cone of steam for maximum penetration of room corners and to fill spaces between pumps and motors. The control valve on the steam snuff-line header is placed at one end of the building, operated with gear and segement, with the operating wheel replaced with a sheave to which a wire cable is attached and wound with several turns so that the wheel will spin the full opening when operated from the remote control station.

The gas entering the plant is analyzed as follows:

	High Pressure Gas, Percent	GPM	Low Pressure Gas, Percent	GPM
Methane	87.44	....	88.99	....
Ethane	6.23	....	4.36	....
Propane	4.25	....	4.07	....
I-Butane	.43	.14	.15	.05
N-Butane	1.01	.32	1.59	.50
I-Pentane	.16	06	.10	.04
N-Pentane	.23	.08	.50	.18
Hexanes plus	.26	.12	.24	.11
Totals	100.00	72	100.00	.88

Treating Plant

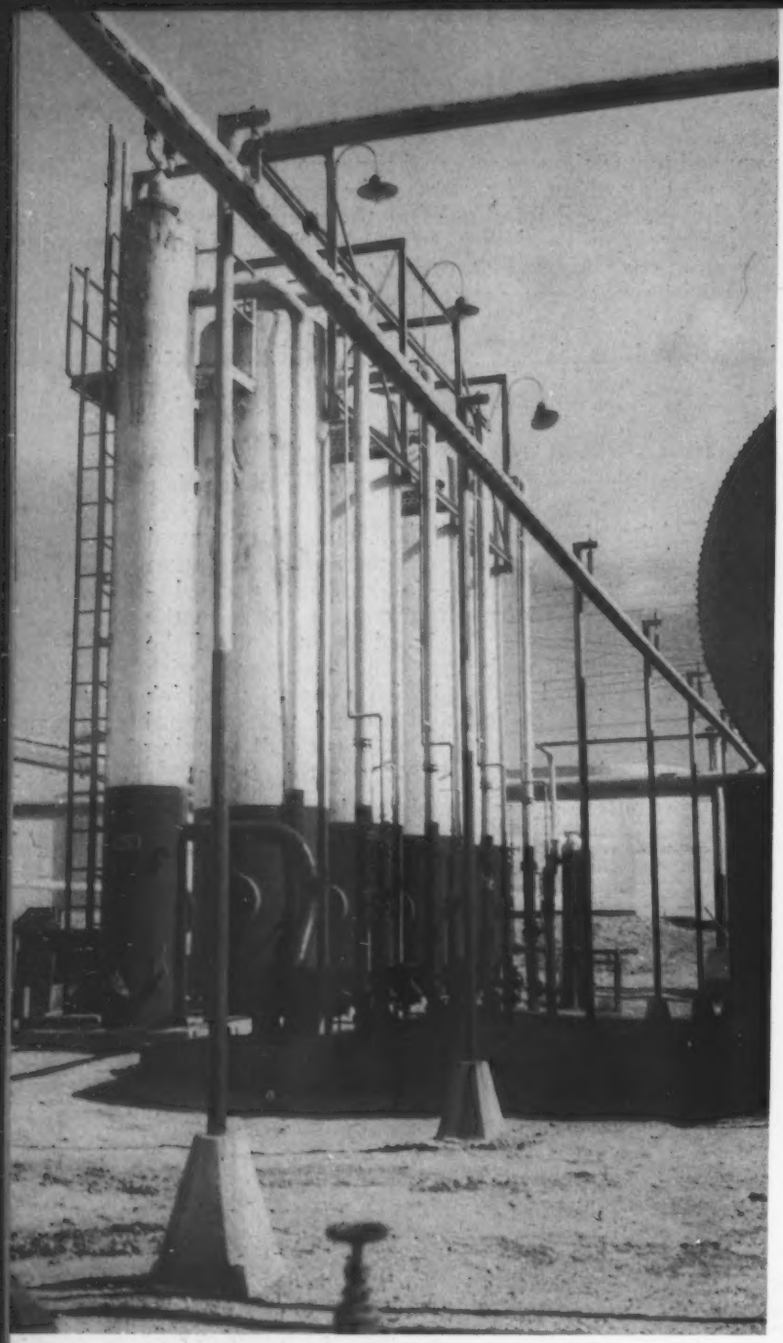
TO treat undesirable compounds out of cracked gasoline manufactured in its McKee refinery, the company included in the design of the unit, a doctor-treating plant. This plant, while having many features in common with others of like nature, is equipped with doctor regeneration equipment which permits this operation to be accomplished under pressure, instead of with the ordinary open top steaming vats.

The system includes four vertical tanks, covered with conical roofs with vapor stacks to remove fumes from the reagent in the vessels. These vessels are used for make-up doctor, to mix chemicals and to store the reagent when not being used. The cracked gasoline is first washed in vertical towers (three operating in series) with caustic solution to remove hydrogen sulphide with the gasoline and caustic solution passing to horizontal tanks for separation. Gasoline is pumped throughout the system with centrifugal pumps, driven by steam turbines, and is contacted with doctor solution in vertical contact columns equipped with cast iron mixing nozzles.

The horizontal vessels to which the contact columns are attached are equipped with collecting drums, similar to tank car domes. These are inverted and welded to the vessel sheets. These drums are equipped with liquid-level instruments operating outlet valves which prevent loss of gasoline by overpumping.

When it becomes necessary to regenerate doctor solution, it is heated by steam coils to a temperature of from 180° F. to 190° F. to drive from the solution any gasoline which may have been entrained. The vessel in which the solution is regenerated is a pressure unit, designed so that all operations may be accomplished with from 15 to 20 pounds pressure. Air is introduced into the mixture by distributing pipes with the solution hot. The method is said to be an improvement upon the atmospheric type of agitation while heating the solution, and by this method it is stated that approximately 75 percent of the litharge is recovered.

The cracked gasoline entering the treating system has an average of about 1.07 percent mercaptans, which are largely removed in the process, and at the



U. O. P. copper sweetening plant employed for sweetening natural gasoline.

same time, it is stated that octane degradation is slight. The cost of this method is $0.021 per barrel for chemicals. The gasoline after treatment has the following characteristics:

Gravity	61.8° API.
Doctor	Negative
Corrosion	Negative
A. S. T. M. Gum	1.5 mgs.
Oxygen Bomb Induction Period	500 minutes
Sulphur	.085%

COPPER SWEETENING

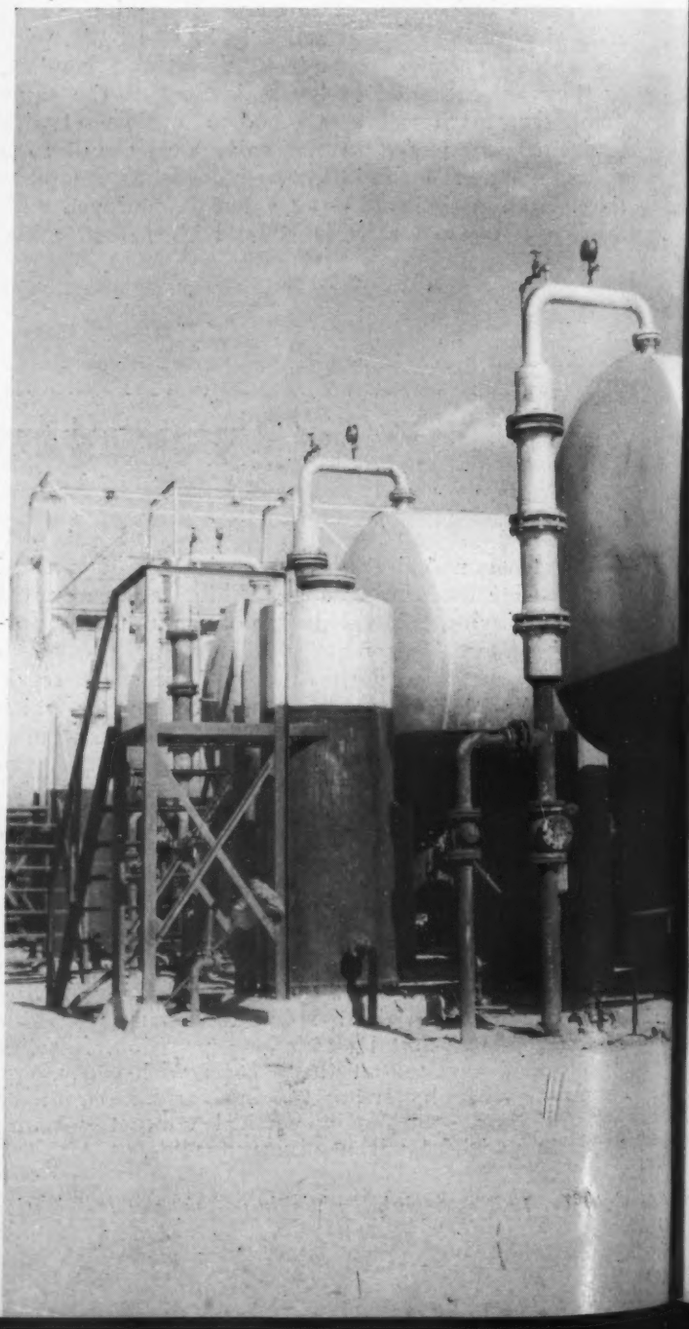
To treat natural gasoline the company erected a Universal Oil Products Company copper sweetener at the time the refinery was constructed. The gasoline, sometimes 26/70 grade, and again 12-pound RVP, practically free of butane, is treated in 4 vertical columns to remove approximately 75 percent of the sulphur.

The treating plant is located near the tank farm where gasoline and other products are stored, and where the company plans to build a pressure vessel with a capacity of 10,000 barrels for propane, and another with a capacity of 100,000 barrels for natural gasoline. Four columns make up the major portion of the treating system. These have a diameter of 3 feet, 6 inches, and are 24 feet high. Piping is attached to these towers to pass gasoline downward through the reagent with which each tower is filled, and connections to introduce compressed air with the gasoline at the time it enters the column manifolds.

Each tower is filled with 4 tons of reagent, consisting of 1 ton of copper sulphate, 1 ton of ammonium chloride and 2 tons of ground Italian pumice stone, with the chemicals and the pumice stone thoroughly mixed in suitable boxes before being placed in the columns. After the sweetening agent is introduced into the columns, approximately 3 percent water is added to the charge.

The columns are usually operated in pairs, with 2 in service and 2 removed from the line, alternating operation of the towers each 24 hours, or perhaps keeping a pair idle for as long as 2 weeks at a time. While the idle pair is off stream the reagent is regenerated by blowing with air. During operation of

Showing details of manifolding, piping, and mixing nozzle arrangement in doctor sweetening plant.



the active pair of towers, air is introduced with the gasoline at the rate of .67 cubic foot per barrel.

In operating this treating plant the treating force is relieved of much work by the automatic features which include constant volume flowing through the unit. The gasoline is taken from the gasoline plant stabilizer reboiler surge drum at 200 pounds working pressure, and reduced at the columns to 45 pounds. With flow-meters attached to orifice plates in the gasoline piping connected to each tower, the treater adjusts the amount of air required and the plant operates without attention until it is necessary to switch to the regenerated towers. Therefore, the cost of labor for treating is low. The chemical cost for this plant is also low. Having treated 579,806 barrels of natural through this unit, the amount expended for chemicals was $2,365.00. Reduced to cost per barrel, the amount was $0.00408. Reduced to cost per gallon the volume passed through the plant was 24,351,852 gallons, which gives a per-gallon cost of treatment of $0.0000971.

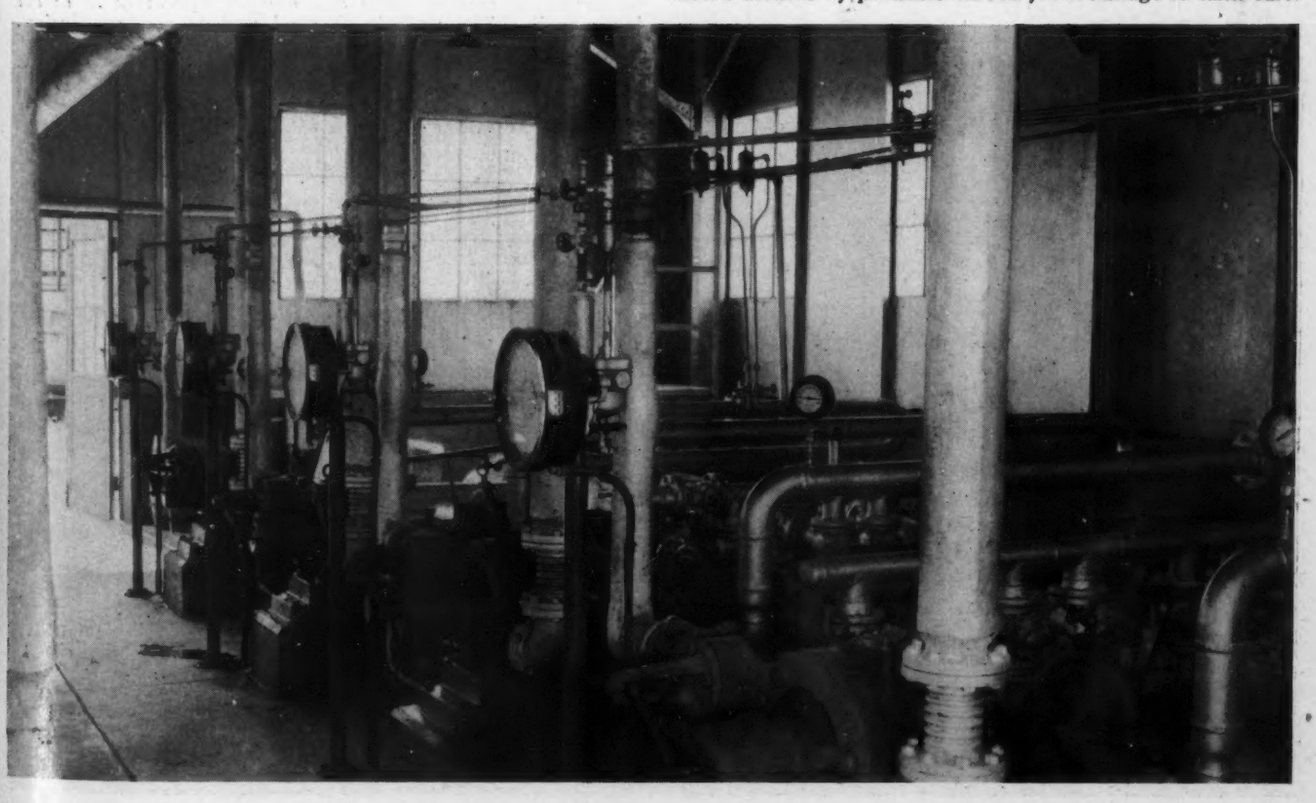
Loading Equipment

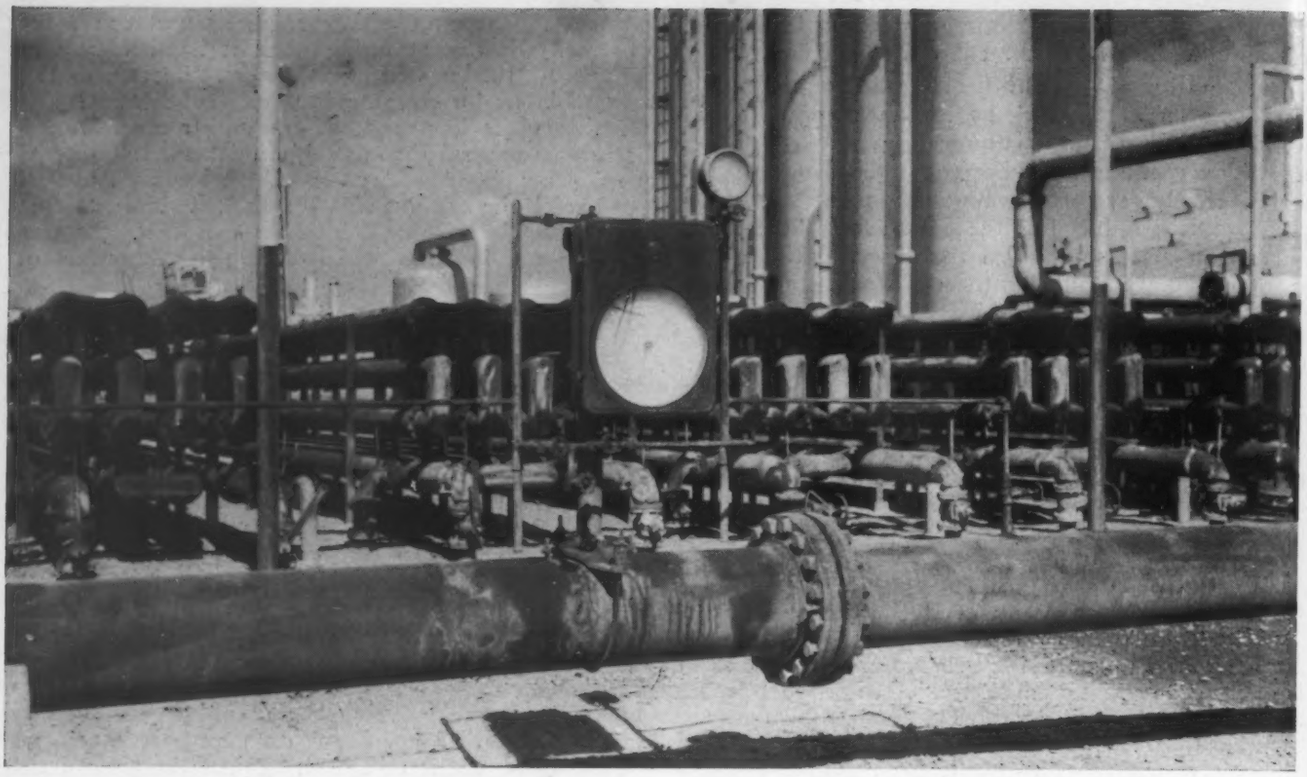
THE plant rack is built of steel throughout, having product piping carried on a structure above the walk, and loading-pipe headers arranged at right angle to the rack. These are welded to product piping at tank car length intervals. The loading headers are secured to the under side of steel structure with U bolts which provides sufficient rigidity. Connections at each end of the loading headers permit loading of two cars at one time from each header. Connections are swing type which allows piping for the tank car connection to hang in a vertical position to clear the engine and switching crew.

Tank car walkways, which permit employees to pass freely from rack to shell of tank car are part of the rack, attached to the structure by hinge connections. Counter-weights are attached to walks by steel cables, operating in small pulleys connected with U bolts to the overhead frame of the loading rack. Chains are also attached to both sides of walks which limit the movement, and are free to fall in position independent of tank car runways. When not in use these walks fold back against the side of the rack to clear the track.

On each siding where tank cars are spotted for loading provisions are made to salvage drainings and are permanent fixtures. Steel vats, welded to shape, and wide as the inside of the track collect gasoline and other products drained through the outlet valve. Each basin is connected to a common gathering system which leads to a sump. Material

Interior of transfer pump house showing flow meters which record volume of products moved from storage to tank cars.



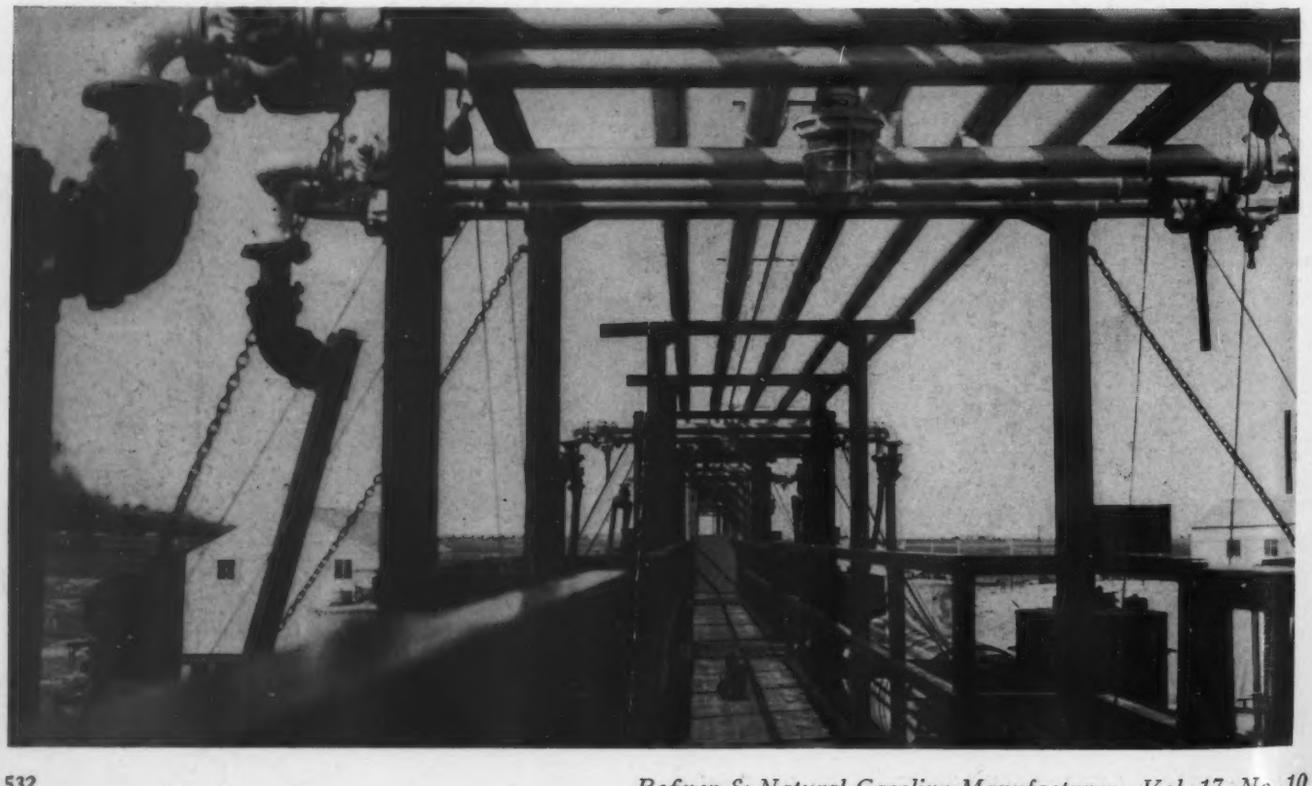


Meter measuring gas entering gasoline plant in foreground, with heat exchange system for gasoline plant operation in the immediate background.

pumped from the recovery system are pumped to refinery slops for rerunning.

With no underground piping, leaks which might otherwise go undiscovered are detected at once, and repairs are made without undue loss of material. With electric conduit passing along the overhead structure of the rack, no goosenecks are required, as vapor-proof lamps are directly above the operator's head. Hose connected to the loading rack header swings may be easily attached to the tank car loading pipes or tank car loading dome covers without difficulty as they hang while idle, beside the loading rack swinging walks in easy reach.

Arrangement of piping on the loading rack which provides unobstructed view of lines and enables operators to detect leaks easily. The rack is all steel and of modern design.



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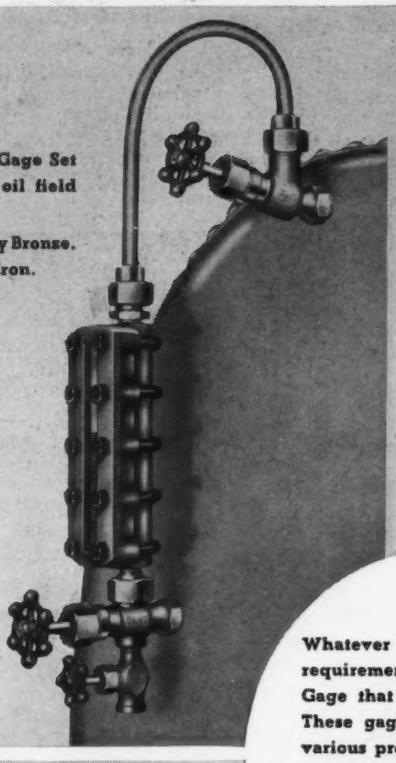
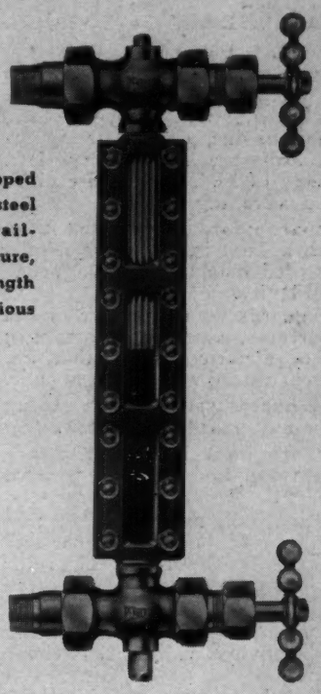


Reflex Water Gage Set designed for oil field boilers.

Type A—Navy Bronze.
Type B—All Iron.



Reflex Gage equipped with drop forged steel gage valves. Available for any pressure, temperature or length required and various liquids.

Whatever your liquid level gage requirements, there is a Penberthy Gage that will meet your needs. These gages are suitable for the various pressure and temperature requirements of the oil industry. Write for a copy of new catalog.

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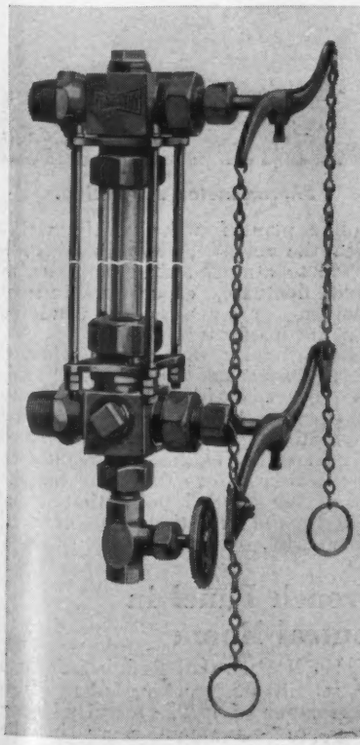
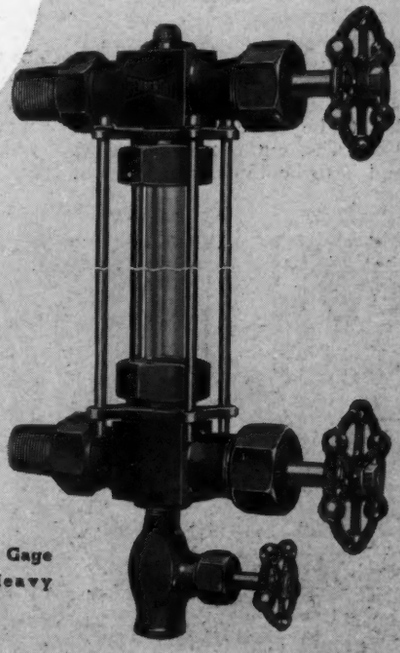


Navy Type Gage
Extra Heavy Bronze



All Iron Gage
Extra Heavy

PENBERTHY INJECTOR COMPANY **Manufacturers of QUALITY PRODUCTS Since 1886**
DETROIT, MICH. • Canadian Plant, Windsor, Ont.

IDEAS to help plant efficiency . . .

Wire Cloth Guards For the Refinery

IT IS commendable practice, for the sake of safety, to place guards around dangerous moving machinery—motors, belts, gears, chains, etc. In many instances guards are required by law. Guards made of high grade wire cloth have these advantages:

1. They are more transparent than other guards. That is, all of the details of the guarded machine can be "seen" without difficulty.

2. Wire guards do not hinder or deflect air currents, which is important in the case of electric motors that are likely to heat where ventilation is poor.

3. Wire guards can be made strong enough for any guarding purpose.

4. They are light in weight, hence can be removed and handled without difficulty.

5. They are easily made. The fact that wire cloth can be bent to almost any desired shape is important. Thus for some enclosures a single joint often suffices.

6. Stiff wire cloth is self-supporting and seldom requires additional intricate frame work.

An easy and excellent way in which to make wire guards for almost any purpose is to make the frame work out of angle iron and the sides out of wire cloth of suitable mesh.

First make the frame. Angle iron is not easily bent without cutting out portions of the flange. That is, cut out some V's from the inner flange where the bend is to be made. If the bend is to be 90 degrees, cut out a square V. If the bend is to be 45 degrees, cut out a 45-degree V, and so on. In other words, cut out a V whose angle is equal to the bend wanted.

After the frame is formed, put in the wire cloth or screen. The quickest way to fasten the wire in place is via the welding torch. The same torch may be usefully employed for welding the frame work together before proceeding with the wire. Simply "spot weld" the wire terminals in place on the inner flange of the frame. If no welding outfit is available the wire may be either riveted or bolted in place. Punch holes through the inner flange at the wire terminals and then rivet or bolt. When carefully made entirely of metal, a guard should last indefinitely.

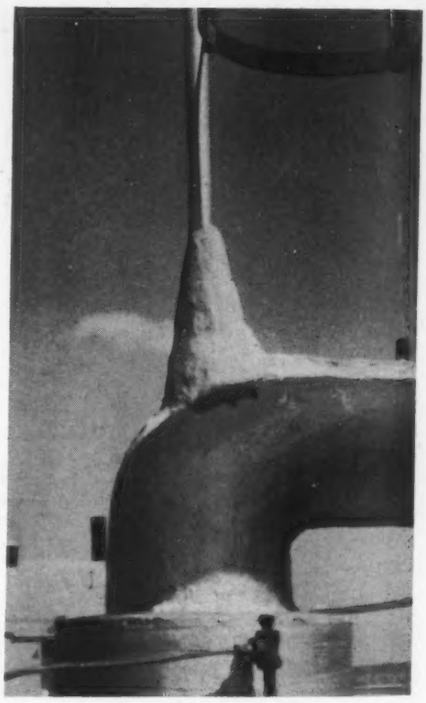
Drum Visually Checks Operation of Steam Trap

WHEN operating steam traps which remove the condensate from preheaters, reboilers and the like, checking of the amount of water handled is easily accomplished in Coltexo Gasoline Corporation's Rodessa gasoline plant by the use of a calibrated drum placed in the line leading from the exchanger. The usual type of drum used is made from ordinary piping, equipped with gauge glass fittings placed near each end to provide readings for the length of the drum. Calibration marks are made on the glass by etching, or in some cases, gauge sticks are employed. In either case, it only requires a very short time for the operator to check the amount of condensed steam which is being made in the exchanger and removed by the steam trap.

Gauging drum for determining the amount of condensed steam handled by the steam trap at the left.

Thermometer Protection

WHEN checking readings between recording the thermometer in control room and the test thermometer in reboiler piping, a discrepancy of about 10 degrees F. was discovered. After determining that the recorder was accurate and not at fault, Deep Oil Development Company in the K.M.A. field



Thermometer Protection.

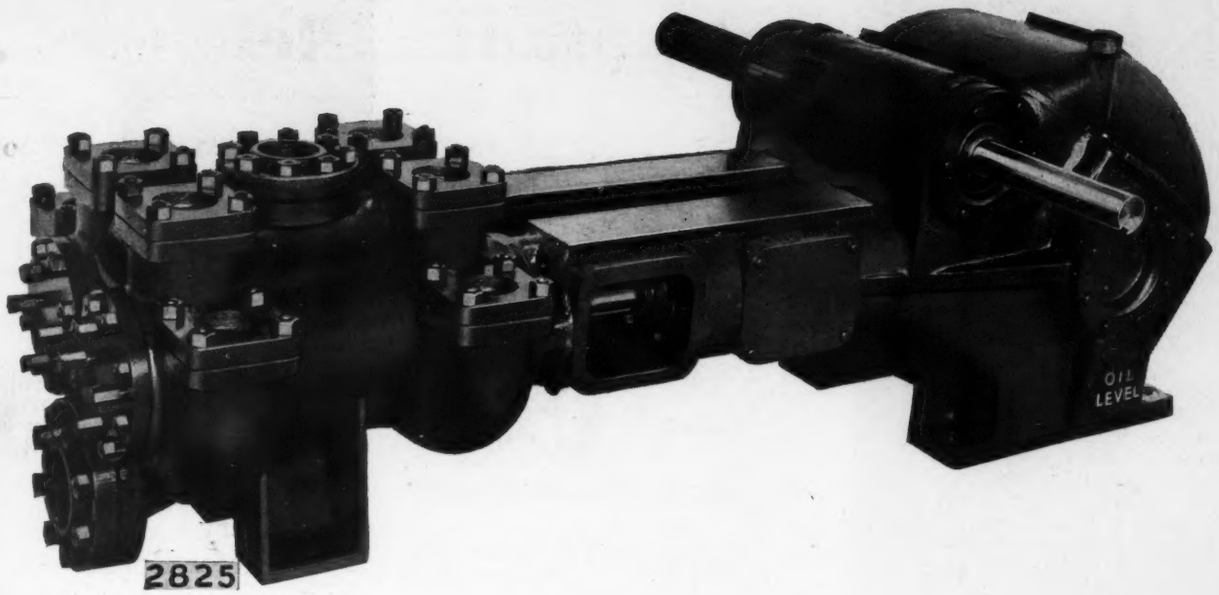
gasoline plant found that the well in which the recorder bulb was installed reacted to atmospheric conditions, and would fluctuate, especially during a rainstorm, or when a cold wind blew upon the instrument.

The difficulty was solved when the bulb and a part of the gas-filled tubing was covered with plastic magnesia. This covering prevented radiation of temperature from the well, and caused the heat to be retained sufficiently that the recorder shows the same temperature at the control point that is indicated by the test thermometer in the well nearby.

Wrench Panel in Control Room

WHEN Barnsdall Refining Company rebuilt its cracking plant during the summer of 1937, several additional pieces of equipment were installed, among which were two gas engines used to drive hot oil pumps. Special tools and the usual types of wrenches are kept separated from each other on

THE PRODUCER



We call her the producer because she produces. She always comes through and does the job in spite of discouraging conditions.

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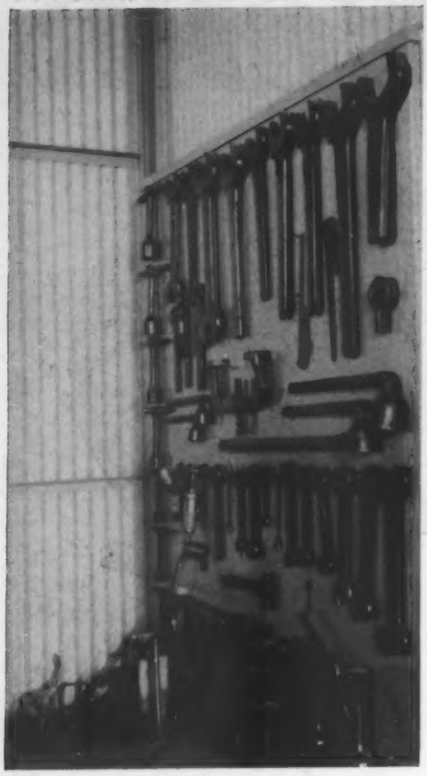


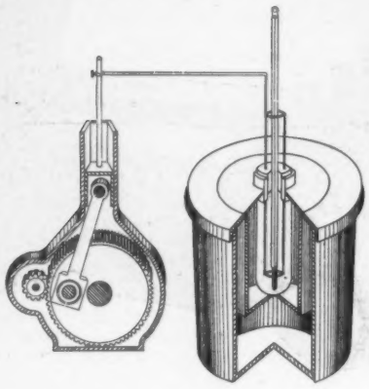
Every Wrench in Place.

a panel placed in the corner of the building which houses these engines. The board is made of planking, with a trim around the edges, and painted gray. Each wrench used in the building, together with pullers and the like, are hung on special hangers, outlined in pencil, then the surface they cover painted black.

The board not only serves as a reminder that a certain wrench is placed on its special hook, but with a black splotch glaring from the board denotes that someone either forgot to return the tool or it is being used. With each wrench in its proper place, adjustments may be made with dispatch with a minimum amount of shut-down time.

Mechanical Melting Point Apparatus

PRESENT day competition is so keen that the necessity for accurate laboratory tests is steadily increasing. As this necessity increases more mechanical "gadgets" appear in the laboratory supplanting the old time hand methods.



MECHANICAL MELTING POINT APPARATUS

For example to obtain the melting point of wax the sketch illustrates the melting point apparatus connected to a system of gears driven by a small laboratory motor. The large gear has connected to it a connecting rod and cross head which produces the necessary up-and-down motion in determining a melting point. Accurate, even stirring is secured by this method, which is impossible to get by hand stirring.

Ponca City, Oklahoma M.E.W.

Boiler Room Vise Support

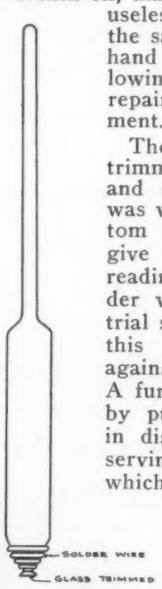
NEEDING a vise frequently in the boiler room to hold various pieces of equipment which required repairs, and not wanting to install a work bench, employes of Warren Petroleum Company designed an all-steel vise holder, or stand, which is permanently attached to the studs of the steel building. Four-inch pipe is used to make an

Boiler Room Vise

ell, one end of which is welded to the stud, with the opposite end fitted with a plate. The vise may be removed, position changed, or locked for heavy work with no fear of turning a bench over.

Temporary Hydrometer Repair

THE mercury tip of a hydrometer was broken off, thus making the instrument useless. But, as another with the same range was not on hand immediately, the following method was used to repair the broken instrument.



The broken glass was trimmed off the bottom, and sufficient solder wire was wound around the bottom of the instrument to give the correct gravity reading. The weight of solder wire was adjusted by trial so that the reading on this hydrometer checked against another hydrometer. A further check was taken by putting the instrument in distilled water and observing the gravity reading which should be 10.

Winnipeg, Canada. W. J. D.

Bleeder lines from steam connections on turbines which permits cleaning out piping after a shutdown to prevent freezing; condensate running into common header beneath concrete floor and to sewer for disposal.

Steam Line Drains

SO that steam lines attached to turbines in East Texas Refining Company's gasoline plant in Miller County, Arkansas, may be drained of all condensate, angle fittings are installed above the turbine intake, with the side opening pointing downward towards the pump room floor. Reducing fittings are attached to these angle openings with a ½-inch line leading to a common drain beneath the concrete floor. Screw-bonnet type valves are installed in these lines, below which are lip unions for disassembling for repair. Without funnel openings above the floor, no water is sent flying over equipment when draining steam lines, and it is much easier to keep the pump room clean.

[*Continued from page 494*]

With increasing pressure of a magnitude sufficient to produce retrograde condensation two actions probably occur. When the density of the gas over the liquid is increased past the point at which the liquid existed, then the liquid assumes the density of the gas and enters into that state. At the same time, the increased density produces a disruptive molecular activity that further induces the liquid to enter the gaseous state. Assuming other liquid hydrocarbons to remain, they would vaporize, fractionally, as the pressure increased. Just how far down the series of hydrocarbons this action can be carried is problematical. Experimental work to define the exact critical pressures at which the various compounds reenter the gaseous state would be an important key to the question. The answers to the many questions brought up by retrograde condensation are for the near future. Materials and machinery for construction of the necessary plants are readily available.

Approved Respiratory Protective Devices

A LIST of respiratory protective devices approved by the Bureau of Mines, United States Department of the Interior, has just been published.

To insure that safe, satisfactory and reliable respiratory protective devices will be available the Bureau of Mines has established schedules of minimum requirements for oxygen breathing apparatus, gas masks, supplied-air respirators (hose masks, airline respirators, and abrasive blasting helmets, hoods, or masks), and mechanical-filter respirators.

Manufacturers of such devices may submit their equipment to the bureau for approval under the requirements of these schedules. Not only must the manufacturer's devices meet the bureau's requirements, but he must have satisfactory equipment for controlling their quality. If all the requirements and tests of the schedules are met, the manufacturer is granted a certificate of approval which states that the equipment has passed the schedule of requirements and gives the limitations of the apparatus. He may advertise these devices as approved by the Bureau of Mines; the bureau may rescind the approval for cause.

Lists of approved devices are published periodically to make available to the public a ready source of information on approved respiratory protective equipment. The present list designated as Information Circular 7030, "List of Respiratory Protective Devices Approved by the Bureau of Mines," by H. H. Schrenk, contains all devices approved to May 20, 1938. Copies of this circular may be obtained from the Bureau of Mines, Washington, D. C.

The Look Box

W. P. R. A. Technical Meetings in Progress

THE Western Petroleum Refiners Association is holding its annual regional technical meetings, arranged by the Manufacturing Committee, this fall at Wichita, Kansas, and Shreveport, Louisiana. Three papers comprise the program at each meeting. At Wichita, where the first meeting was held September 29 the following papers were presented:

"Reclaiming Refinery Material," by E. R. Jones, Skelly Oil Company; "Safety Economics Pertaining to Refineries," Henry W. Boggess, Safety Engineer, Sinclair Prairie Oil Company; "Cracking to Fuel Oil versus Cracking to Coke," by George B. Murphy, Universal Oil Products Company.

At the Shreveport meeting, to be held October 28 at the Washington-Youree Hotel, Mid-Continent crude oils will be analyzed for their value as lubricants, the speaker to be announced later. This particular subject is of considerable importance to Mid-Continent refiners, as well as motorists, and is an effort on the part of the refiners organization to present the true value of Mid-Continent lubricants. Other subjects to be discussed at the Shreveport meeting include furnace walls and arches to be presented by Detrick Arch Company, and "Modern Engines and the Demand on Refiners for Motor Fuels," by W. W. Scheuman, Cities Service Oil Company. These programs were arranged under the direction of L. D. Mann, Cities Service Oil Company, chairman of the Manufacturing Committee.

Conventions

OCT. 19–21	Independent Petroleum Association, of America, Tulsa, Oklahoma.
26	National Petroleum Association, Department of Fire & Accident Prevention, Semi-Annual Meeting, Olean, New York.
28	Western Petroleum Refiners Association, Shreveport, La.
NOV. 11–18	National Automobile Show, Grand Central Palace, New York City.
14–18	American Petroleum Institute, Stevens Hotel, Chicago.
DEC. 5-9	American Society of Mechanical Engineers, New York, N. Y.

Oil Chemists Elect Frolich

THE Petroleum Division, American Chemical Society, at the recent meeting in Milwaukee, elected Dr. Per K. Frolich, research director, Standard Oil Development Company, chairman of the division, succeeding Dr. J. C. Morrell, Universal Oil Products Company, who served as chairman during the past year. Dr. Joseph K. Roberts, research director for Standard Oil Company (Indiana), was elected vice chairman. Dr. C. R. Wagner, chief chemist, The Pure Oil Company, was re-elected secretary-treasurer, with J. C. Morrell and Dr. Frank W. Hall, research director for The Texas Company, elected as directors of the division.

American Gas Association Annual Program

WITH conditions in the gas industry greatly improved as the result of a marked acceleration of local sales efforts backed up by a national drive for new business, executives of gas companies meet in Atlantic City, October 10-13, for the twentieth annual convention of the American Gas Association, with sentiment more optimistic than it has been in three years.

Some of the speakers announced by George F. Mitchell, of Chicago, president of The Peoples Gas Light & Coke Company, who is chairman of the convention's program committee, are:

Floyd L. Carlisle, chairman of the board, Consolidated Edison Company of New York; Dr. E. R. Weidlein, director, Mellon Institute of Industrial Research, Pittsburgh; Charles G. Groff, president, Electrolux, Inc., New York; Joseph E. Pogue, vice president, Chase National Bank, New York; Harold F. Browne, director, management research division, National Industrial Conference Board, New York; Clyde H. Seavey, acting chairman, Federal Power Commission, Washington; Prof. Erwin H. Schell, Massachusetts Institute of Technology, Cambridge, Mass.; K. H. Logan, National Bureau of Standards, Washington; Dr. W. A. Pearl, Armour Institute of Technology, Chicago; and Willard Chevalier, publisher, Business Week, New York.

Listed among the subjects to be presented are regulation, research, national advertising, opportunities of the natural gas industry, elements of a sound industrial relations program, the future of the certified performance gas range, and expanding markets for gas in industry.

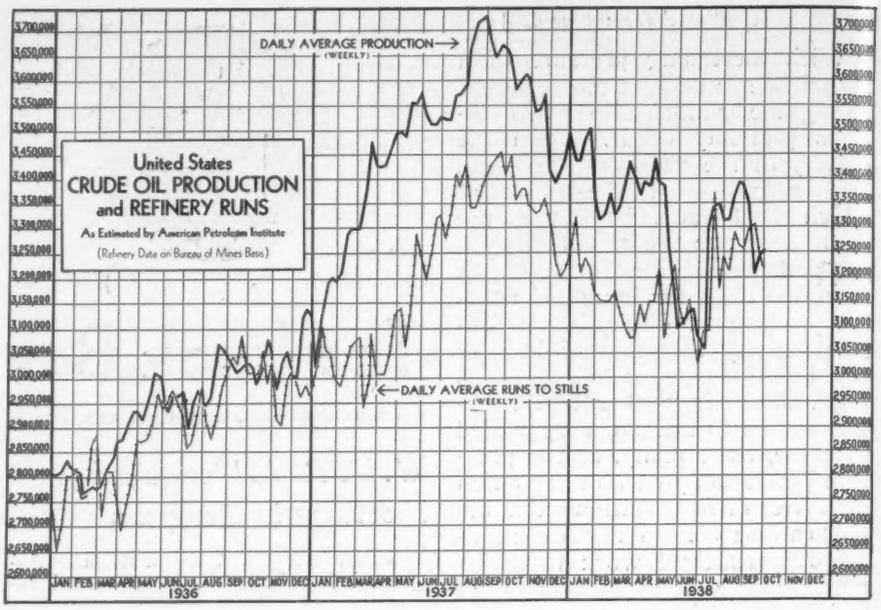
N. C. McGowen of Houston, Texas, president of the association, will open the convention with an analysis of the industry's operations during the past year. Other speakers from within the gas industry will be R. E. Fisher, vice president, Pacific Gas & Electric Company, San Francisco; R. W. Hendee, general manager, Colorado Interstate Gas Company, Colorado Springs; E. F.

Schmidt, vice president, Lone Star Gas Company, Dallas; D. H. Mitchell, vice president, Northern Indiana Public Service Company, Hammond; I. K. Peck, president, Binghamton Gas Works, Binghamton, N. Y.; H. C. Cooper, president, Hope Natural Gas Company, Pittsburgh, and F. M. Banks, vice president, Southern California Gas Company, Los Angeles.

Forecast of Demand For October, 1938

THE daily average supply of domestic crude oil estimated by the Bureau of Mines to meet the market demand in October, 1938, is 3,366,800 barrels. This is 77,500 barrels less than the estimate for September, 1938, and 7 percent less than the actual demand for domestic crude in October, 1937. The decline from a year ago is due chiefly to the fact that a substantial decline in gasoline stocks is estimated for October, 1938, whereas in October, 1937, excess crude runs resulted in an increase of about 3,000,000 barrels in finished gasoline stocks.

Daily average crude oil production and runs to stills during the 5 weeks, July 30 to September 3, averaged 3,383,000 barrels and 3,260,000 barrels, respectively. During this period total crude stocks (including heavy crude in California) declined 3,677,000 barrels, 3,157,000 barrels of which was in domestic grades. The average daily decline in domestic grades of 90,000 barrels, added to the production, gives an apparent daily average demand of 3,473,000 barrels. This compares with the bureau's estimate of 3,438,100 barrels for August. The difference may be attributed to the fact that gasoline stocks were not reduced as might have been expected.



The estimate of motor fuel demand for October, 1938, is 45,800,000 barrels, a gain of 1 percent over demand in October, 1937. The total domestic demand for the first 7 months of 1938 ran slightly under the record of 1937 but this situation was due entirely to the poor record of July, 1938. Indications are that the demand in August, 1938, was at least equal to that in August, 1937, and that by October business recovery will have progressed enough to show a gain in demand over the previous year.

Exports of motor fuel have been estimated as 4,400,000 barrels, the same as the estimate for September.

Stocks of finished and unfinished gasoline on July 31 totaled 76,732,000 barrels; by August 31 these stocks had been reduced to about 71,000,000 barrels, but this was 4 to 5 million barrels above the level of August 31, 1937. Regardless of what happens to these stocks in September, it is obvious that there is no need of repeating the accumulation of October, 1937; rather, there is every reason for feeling that some of the excess will be liquidated this October, the last month for which it is reasonable to expect a reduction. Accordingly, the bureau estimates a reduction of 1,900,000 barrels in finished gasoline stocks in October, 1938.

Benzol and direct sales and losses of natural gasoline have been estimated as 1,000,000 barrels, making refinery production 47,300,000 barrels. This is distributed among the various districts as follows (thousands of barrels): East Coast, 6,220; Appalachian, 1,650; Indiana-Illinois, 8,240; Oklahoma, 2,870; Kansas, 2,680; Texas Inland, 3,720; Texas Gulf Coast, 11,980; Louisiana Gulf Coast, 1,510; North Louisiana-Arkansas, 910; Rocky Mountain, 1,110; California, 6,410.

Natural gasoline consumption at refineries in October is estimated as 8.7 percent of the total production, compared with 8.5 percent in October, 1937. The yield of straight-run and cracked gasoline rose to 44.7 percent in July, 1938, this being the high for the year. With gasoline consumption declining and the domestic-heating season beginning, gasoline yields should logically not increase in October, hence the bureau estimates a yield of 44.4 percent for October, 1938, the same as estimated for September. The application of this yield to the straight-run and cracked production of 43,190,000 barrels gives crude runs of 97,320,000 barrels, or 3,139,000 barrels daily. Of the total, 2,350,000 barrels is the estimate for foreign crude runs.

Data received from the largest exporters indicate a decline in exports of crude in October, compared with Sep-

Trends of United States Production and Stocks

Figures are from American Petroleum Institute weekly reports, except those on crude stocks, which are from Bureau of Mines weekly reports

WEEK ENDED	Crude Oil Production (Barrels Daily)	Crude Runs to Stills (Barrels Daily)	Crude Oil Stocks (Barrels)	Gasoline Stocks (Barrels)	Gas & Fuel Oil Stocks (Barrels)
September 25, 1937	3,666,300	*3,455,000	307,974,000	65,620,000	116,472,000
October 2	3,647,450	3,400,000	309,036,000	65,266,000	117,076,000
October 30	3,602,950	3,345,000	307,140,000	66,836,000	121,070,000
November 27	3,425,800	3,325,000	304,156,000	68,544,000	121,616,000
December 25	3,492,600	3,245,000	303,294,000	74,437,000	118,659,000
January 1, 1938	3,436,600	3,320,000	303,468,000	77,291,000	118,660,000
January 29	3,357,650	3,170,000	304,286,000	84,844,000	118,793,000
February 26	3,322,800	3,170,000	305,167,000	90,719,000	120,958,000
March 19	3,322,550	3,080,000	306,380,000	*93,192,000	122,067,000
March 26	3,405,600	3,080,000	307,557,000	92,858,000	122,979,000
April 30	3,396,150	3,215,000	307,147,000	91,339,000	128,270,000
May 28	3,098,650	3,150,000	301,583,000	87,946,000	134,315,000
June 25	3,083,900	3,025,000	293,463,000	82,412,000	137,801,000
July 30	3,316,400	3,240,000	288,514,000	76,864,000	144,294,000
August 6	3,317,850	3,215,000	287,406,000	75,380,000	144,699,000
August 13	3,359,900	3,295,000	286,251,000	74,387,000	146,261,000
August 20	3,392,700	3,265,000	285,137,000	72,709,000	147,180,000
August 27	3,388,500	3,255,000	285,029,000	71,754,000	146,926,000
September 3	3,349,100	3,195,000	284,919,000	70,514,000	147,646,000
September 10	3,206,900	3,235,000	282,457,000	70,860,000	149,104,000
September 17	3,239,050	3,245,000	280,945,000	69,244,000	149,388,000
September 24, 1938	3,251,150	3,220,000	.....	68,605,000	150,468,000
September 25, 1937	3,666,300	3,455,000	†307,974,000	65,620,000	116,472,000
Change in past year	—11.3%	—6.8%	—9.6%	+4.5%	+29.2%

* All time peak. † Stocks, September 18, 1938.

tember. However, the September estimate of 7,000,000 barrels was probably too low. It was therefore decided to retain the 7,000,000-barrel estimate for October, 1938, pending developments in European trade. The consumption of crude as fuel should logically rise in the fall, hence the estimate for this item and losses has been raised to 2,400,000 barrels.

The total demand for domestic crude in October, 1938, as indicated by the estimates above is 104,370,000 barrels, or 3,366,800 barrels daily.

Compressed Air-Trade Standards Published

THE Compressed Air Institute announces publication of a new edition of "Trade Standards," which is a 112-page book, 8½ by 11 inches in size, with wire binding and an artistic cover design. It is more than double the size of the previous edition and includes such new material as sections on rotary compressors and vacuum pumps, centrifugal compressors and blowers, compressor accessories, rock drills, and pneumatic tools; additional charts, tables and data; also an up-to-date revision of material previously published on reciprocating compressors and vacuum pumps (stationary type), portable compressors, and a description of the method of testing displacement compressors, blowers and vacuum pumps conforming to the revised A.S.M.E. Code now under preparation. The book is presented in two parts, and 15 sections, with the various sectional headings appearing as follows: Definition of terms, nomenclature and terminology, rating standards and guarantees, test standards, installation and care of compressors, lubrication, data, tables, formulae, some uses of compressed air, reciprocating compressors and vacuum pumps; rotary compressors and vacuum pumps, centrifugal compressors and exhausters, compressor accessories, portable compressors, rock drills and accessories, and pneumatic tools and accessories. Copies can be secured from the institute, 90 West Street, New York. Price $1.00 plus postage.

Protecting Metals Against Corrosion

THE American Society for Testing Materials, 260 South Broad Street, Philadelphia, announces the "Symposium on Protecting Metals Against Corrosions," is now ready for distributing at 50 cents per copy.

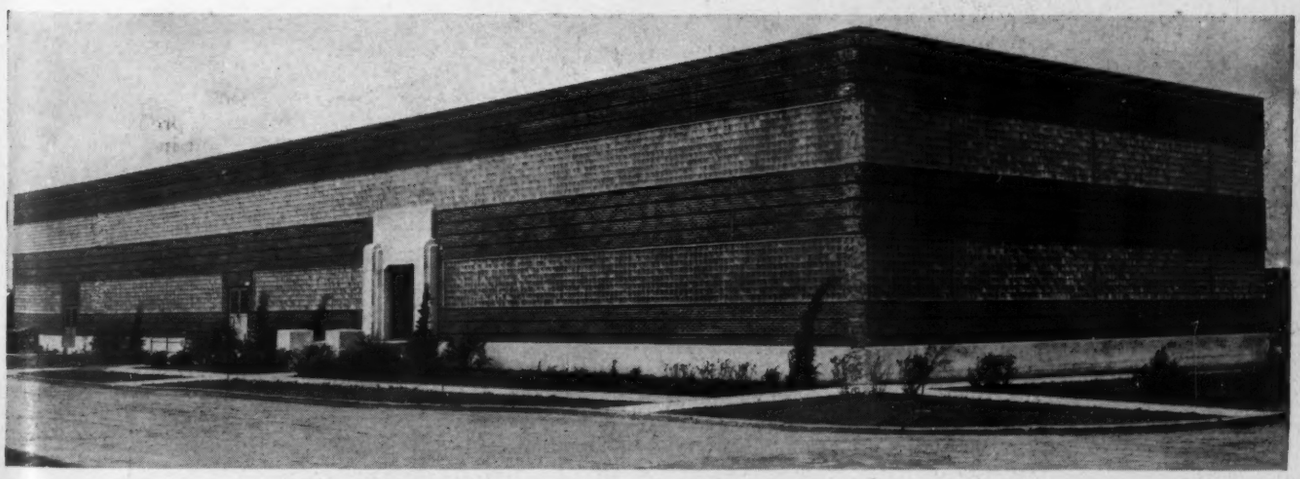
This symposium is comprised of the four papers presented at a meeting sponsored by the Detroit District Committee of the A.S.T.M., and the papers include "Corrosion-Resistant Alloys," by H. W. Gillett, Metallurgist, Batelle Memorial Institute; "Protection of Base Metals by the Use of Metallic Coatings," by C. E. Heussner, Materials Engineer, Chrysler Corporation; "The Pre-Treatment of Metals," by R. J. Wirshing, Research Engineer, General Motors Corporation; and a discussion on "Corrosion Protection by Means of Organic Coatings," by J. L. McCloud, Metallurgical Chemist, Ford Motor Company.

Phillips Laboratory Is Modern and Complete

RESEARCH with Phillips Petroleum Company has grown up from space in a garage on the yard of the DeNoya gasoline plant in the Burbank field to a modern building in Bartlesville. The research program is divided into sections. Of those pertaining to production the following are excerpts from releases by the company:

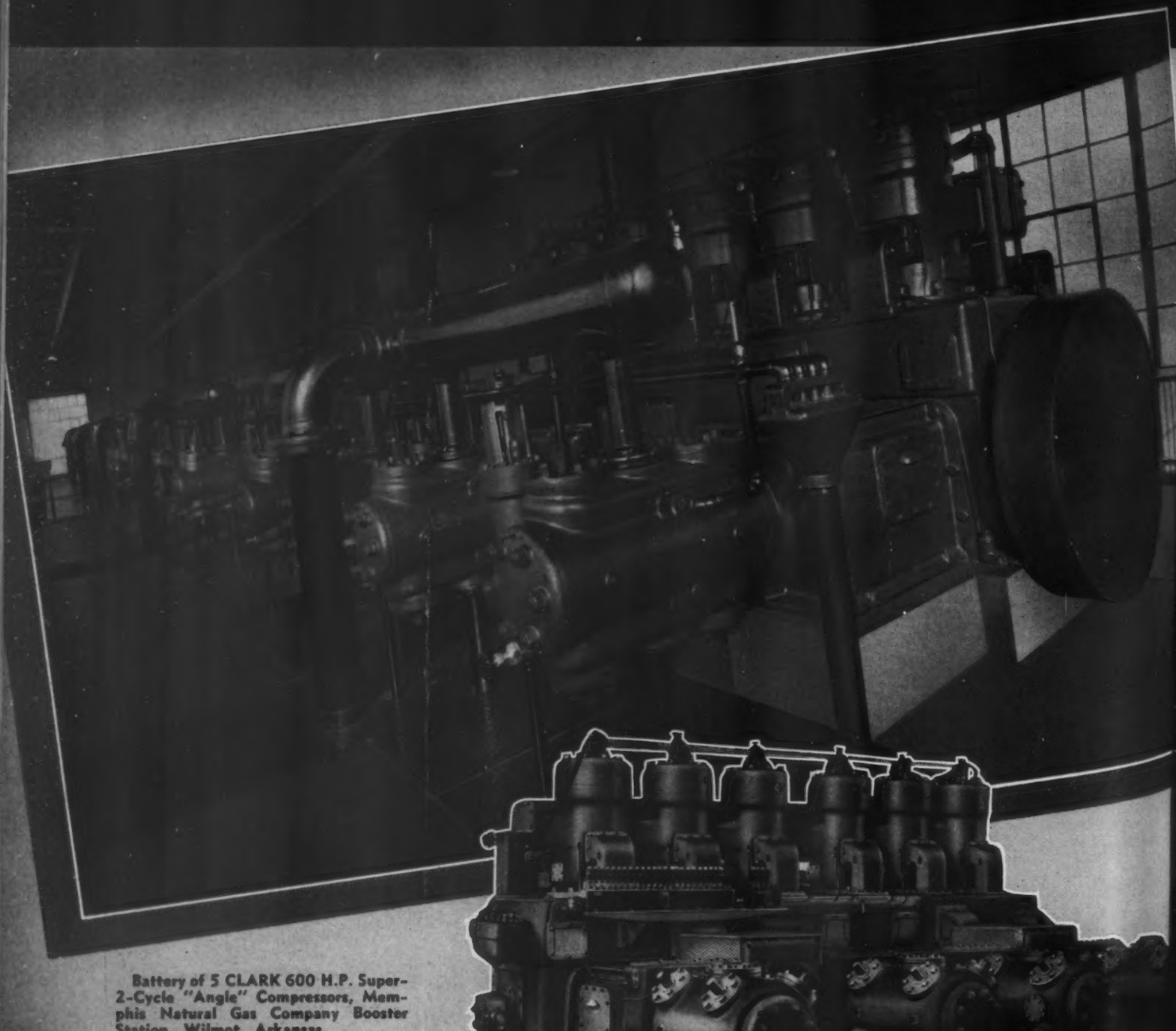
"Starting in 1925 with eight men the Phillips Research Department now employs 93 persons. It is headed by G. G. Oberfell, vice president in charge of

Administration of research programs is by sections, and this is the production service section, where emulsions, sand conditions, etc., are a few of the problems that come under scientific scrutiny. The view is an excellent portrayal of facilities and conditions under which the laboratory force works.



Concrete, brick, glass, steel and no windows are the outside view of Phillips Petroleum Company's new laboratory. Wall construction is such that no weight rests on the two sections of glass, which afford light and eliminate windows. The building, two stories with basement under half its area, is 70 by 172 by 210 feet.

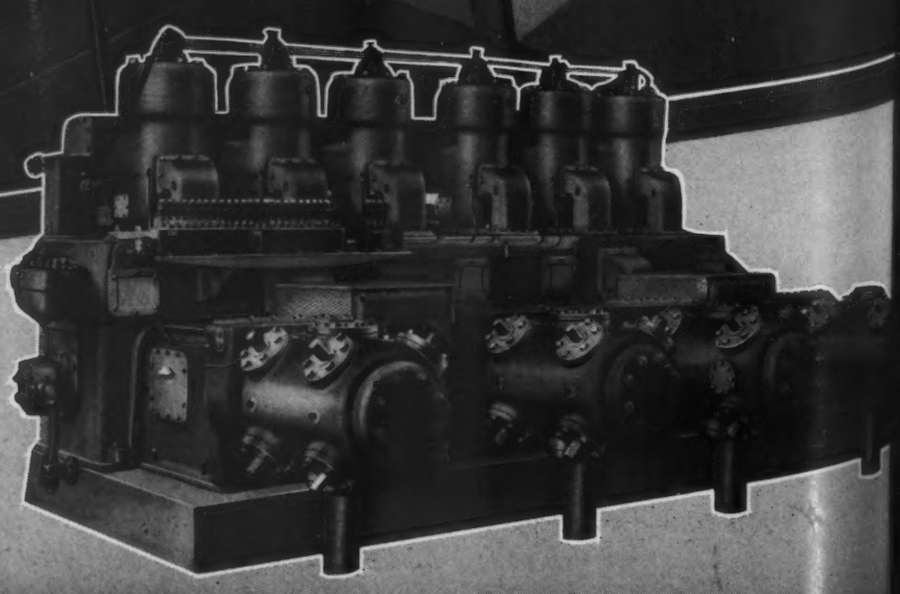
"Performance exceeded our



Battery of 5 CLARK 600 H.P. Super-2-Cycle "Angle" Compressors, Memphis Natural Gas Company Booster Station, Wilmot, Arkansas.

●

At right: 6-cylinder, 600 H.P. CLARK "Angle." Also built in 2, 3, 4, and 5-cylinder sizes, ranging from 200 to 500 H.P.



of the station expectations"

writes H. C. Wallace,
Vice-President, Memphis Natural Gas Co.

IN response to an inquiry regarding the performance of the CLARK "Angle" Compressors at the Wilmot, Arkansas, Booster Station of the Memphis Natural Gas Company—H. C. Wallace, Vice-President of the company, writes us:

"Replying to your inquiry concerning the performance of Clark "Angle" Compressors and our opinion of this equipment:

"As you know, in the summer of 1937 we constructed a compressor station on our main line at Wilmot, Arkansas, equipped with five 600 H. P. Clark "Angle" machines. This station was completed in the fall and placed in service December 1, and was operated at capacity from then on through the period of our heavy peak demands until about March 15. During this time we experienced no operating difficulties of any kind, and the performance of the station generally exceeded our expectations. We found this equipment particularly adaptable to our service due to the flexibility of the units and the short time required for them to come on and go off the line.

"By the use of this equipment at this particular point we were able to effect a considerable saving, due to the compact design of the plant, which was made possible by the use of this particular type of equipment.

"This summer we have inspected the compressors and gas engines carefully and find that there has been no appreciable wear due to the season's operation, and nothing but ordinary maintenance has been required. As a result of this first year's experience, we believe that your prediction regarding low maintenance cost at this station will be realized."

CLARK "Angles" are bringing users three great savings: On Installation cost because compact design saves on transportation, foundations, and building; on Operation because CLARK Super-2-Cycle Fuel Injection saves 1/3 on fuel, giving 4-cycle fuel economy; on Maintenance due to the rugged simplicity of CLARK 2-cycle design.

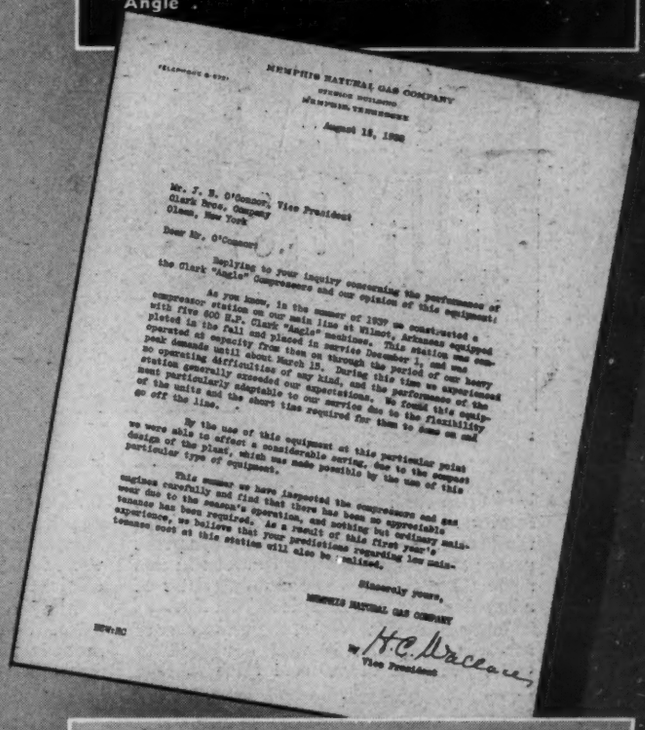
Write for our new catalog; also our 20-page booklet giving complete engineering description of the Wilmot Station.

CLARK BROS. COMPANY . . Olean, New York, U. S. A.

Export Office: 30 Rockefeller Plaza, New York. Midcontinent Sales Offices and Warehouses: Tulsa, Okla.; Dallas and Houston, Texas. West Coast Office: Smith-Booth-Usher, 2001 Santa Fe Ave., Los Angeles. Foreign Offices: 72 Turnmill St., E. C. 1, London, England; 4 Str. General Poetas, Bucharest, Roumania.

CLARK

Main Compressor Building and Meter House, Wilmot Station. Note saving in size of building made possible by compact design of the CLARK "Angle".



MEMPHIS NATURAL GAS COMPANY
STRONG BUILDING
MEMPHIS, TENNESSEE

August 18, 1938

Mr. J. B. O'Connor, Vice President
Clark Bros. Company
Olean, New York

Dear Mr. O'Connor:

Replying to your inquiry concerning the performance of the Clark "Angle" Compressors and our opinion of this equipment:

As you know, in the summer of 1937 we constructed a compressor station on our main line at Wilmot, Arkansas equipped with five 600 H.P. Clark "Angle" machines. This station was completed in the fall and placed in service December 1, and was operated at capacity from then on through the period of our heavy peak demands until about March 15. During this time we experienced no operating difficulties of any kind, and the performance of the station generally exceeded our expectations. We found this equipment particularly adaptable to our service due to the flexibility of the units and the short time required for them to come on and go off the line.

By the use of this equipment at this particular point we were able to effect a considerable saving, due to the compact design of the plant, which was made possible by the use of this particular type of equipment.

This summer we have inspected the compressors and gas engines carefully and find that there has been no appreciable wear due to the season's operation, and nothing but ordinary maintenance has been required. As a result of this first year's experience, we believe that your prediction regarding low maintenance cost at this station will also be realized.

Sincerely yours,
MEMPHIS NATURAL GAS COMPANY
By H. C. Wallace
Vice President

HCW:RC

General view of Wilmot Station, showing cooling tower, main compressor building and auxiliary building.

research; R. C. Alden, director; T. W. Legatski and F. E. Frey, assistant directors, and W. A. Schultze, chief chemist. Beginning at Burbank, Oklahoma, in a 20x20 garage, with very limited equipment the majority of research work was transferred to Bartlesville in 1926, and the department now occupies a new building recognized as one of the largest and best equipped research buildings in the oil industry.

"The new 'glass house' has glass brick walls instead of windows, which provide a bright, clear, diffused light, easy on the eyes and aiding greatly in performing delicate experiments.

"The production research section deals with the behavior of oil and gas mixtures as they naturally occur. Producing horizons are being studied intensively for the ultimate purpose of increasing available recoveries. The problem of secondary recoveries are also considered.

"In the production service section is carried on a most valuable personal service to the company employees, the examination of all drinking water that is sent in from all outposts. Its members also study the problem of salt water disposal, water treating for water flooding and the breaking of water-crude oil emulsions."

A. P. I. Natural Gasoline Code Available

THE Main Committee on Measuring, Sampling and Testing Natural Gas and Natural Gasoline of the Production Division of the Institute, under the chairmanship of F. E. Rice (vice president, Phillips Petroleum Company, Bartlesville, Oklahoma), with a membership of 55 representative officials and technical men selected from the industry over the United States, announces publication of Code 50-B: "Measuring, Sampling and Testing Natural Gasoline (Tentative)," and considers this an equally important forward step as was the publication of Code 50-A: "Measuring, Sampling and Testing Natural Gas (Tentative)," last year.

The committee has carefully selected for inclusion in Code 50-B those standards and other practices which from technical soundness, general usage, or simplicity have been found most dependable and worthy of broad dissemination. Only methods which were judged by the committee to be in widespread use in commercial transactions were considered suitable for inclusion in the code. Methods applicable strictly to plant operations have been omitted.

An important feature of this code is the comprehensive procedure for sampling volatile petroleum products. In the preparation of this, sampling procedures prescribed by various standard test methods, technical associations, and other sources were carefully studied. Consideration was given the types of vessels from which samples would need to be secured and the tests which would be required on these samples for commercial purposes. The result, it is believed, satisfied a need which has been long existent.

While it has not been the purpose of this committee to develop new standards or procedures, during the course of its studies some inadequacies of prevailing standards became apparent. These were directed to the attention of the technical society or trade association which had established the standard in question and most of the revisions suggested have subsequently become a part of the standard referred to.

Code 50-B as adopted and now published is tentative. It is the policy of the Institute to maintain a standing committee for each standard and code adopted to consider additional test procedures and modifications or revisions of those already published, thereby insuring the adoption and recommendation for use of the best and most suitable standards.

The detailed considerations in measuring, sampling and testing natural gasoline have been carried on by a Technical Sub-committee, known as Group 1, under the chairmanship of S. S. Smith, Shell Petroleum Corporation, St. Louis, Missouri, supplemented by four additional sub-committees as follows:

Sub-committee 1-A—Tank and Temperature Measurement, H. R. Auerswald, chairman, Gulf Oil Corporation, Tulsa, Oklahoma;

Sub-committee 1-B—Measurement by Meter, P. S. Magruder, chairman, General Petroleum Corporation of California, Los Angeles;

Sub-committee 1-C—Sampling, R. D. Hanley, chairman, Magnolia Petroleum Company, Dallas, Texas, and

Sub-committee 1-D—Testing, R. C. Alden, chairman, Phillips Petroleum Company, Bartlesville, Oklahoma.

This work was initiated in November, 1932; the code was approved by the Main Committee by letter-ballot in the spring of 1938, and ratified for

A TIGHTER SEAL WITH LESS FRICTION?
SEA RINGS are completely automatic. The flexible lip is held tightly to the rod by the pressure on the work stroke, but releases on the return. Unnecessary friction is eliminated, there is less wear on both rod and packing.
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when you use
SEA RINGS

INCREASED operating efficiency and less time lost for repacking . . . that is the record J-M Sea Rings have made in plants throughout the country. Three features explain their exceptional service—proper composition, correct design and rugged construction. And these same three features are characteristic of all packings in the complete J-M line.

Johns-Manville, largest manufacturer of asbestos products, is well equipped to make packings of unusual quality. J-M Packings are the result of 60 years' research and experience in the development of materials specifically suited to various mechanical equipment and service conditions. No matter what your packing problem is, there is a J-M Packing that can handle it efficiently, dependably and economically.

The J-M Packings Catalog will help you select the right packing for every requirement in your plant. For your copy, write Johns-Manville, 22 E. 40th St., N. Y. C.

JM JOHNS-MANVILLE PACKINGS & GASKETS
AVAILABLE ON PHONE CALL AT YOUR NEAREST DISTRIBUTOR

Contract Completion

PERFORMANCE eminently satisfactory to refiners—anticipating scheduled delivery—is characteristic of Foster Wheeler contracts for complete refineries, processing units and equipment. Designers, engineers, fabricators, and erectors cooperate to maintain or better short contract delivery periods as exemplified by recent completions:

1 **4,400 barrels per day circulating gas oil heater.**

Contract shipping date was stipulated as 4 months from date of order. Shipment made 3½ months after order was received.

2 **18,000 gph pressure distillate heater,**
12,500 gph reformed gasoline reboiler,
22,200 gph circulating gas oil heater and
23,000 gph gasoline heater.

Complete erection was scheduled for 4 units: 4½ months. Drying out fires were lighted 4 months from date of order.

3 **127,500 lbs. per hour asphalt saturant heater.**

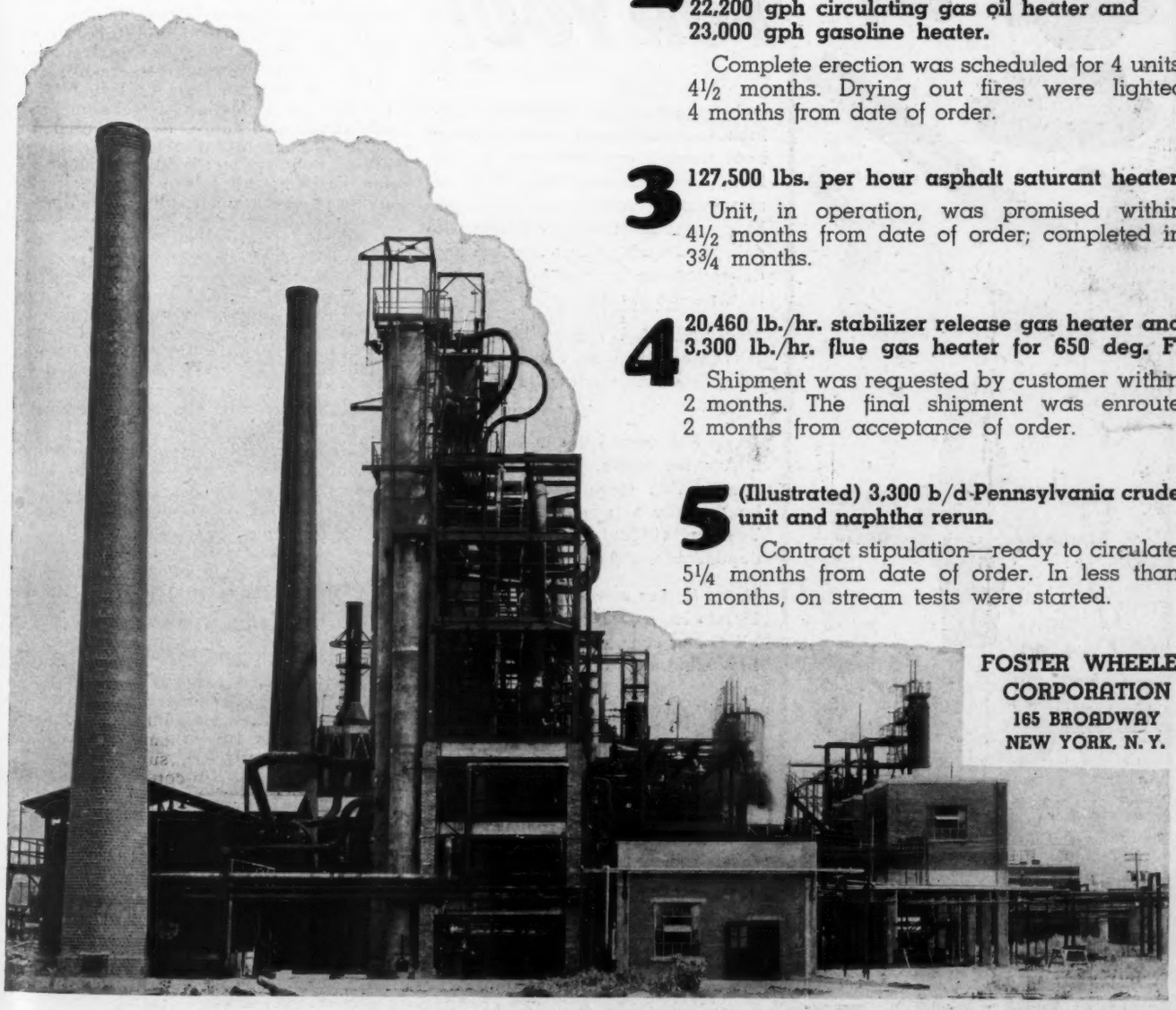
Unit, in operation, was promised within 4½ months from date of order; completed in 3¾ months.

4 **20,460 lb./hr. stabilizer release gas heater and 3,300 lb./hr. flue gas heater for 650 deg. F.**

Shipment was requested by customer within 2 months. The final shipment was enroute 2 months from acceptance of order.

5 **(Illustrated) 3,300 b/d Pennsylvania crude unit and naphtha rerun.**

Contract stipulation—ready to circulate 5¼ months from date of order. In less than 5 months, on stream tests were started.



FOSTER WHEELER CORPORATION
165 BROADWAY
NEW YORK, N. Y.

FOSTER WHEELER

printing at the Wichita meeting, May, 1938.

Code 50-B is the result of intensive study and exchange of ideas by the members of the committee in utilization of specifications previously prepared by other organizations, and often in conjunction with representatives of those organizations, such as the California Natural Gasoline Association, the Natural Gasoline Association of America, and the American Society for Testing Materials.

The committee has also adopted a Code (50-A) on Measuring, Sampling and Testing Natural Gas (Tentative), which was prepared by the Group 2 Sub-committee—George P. Bunn (Phillips Petroleum Company, Bartlesville, Oklahoma) chairman. The code was published in September, 1937.

Single copies of Code 50-B are available from the New York and Dallas offices of the Institute at 35c each. Quantity prices are lower.

Novel Device for Measuring Gases

A DEVICE of remarkable accuracy and precision which is of the utmost value as a scientific aid in maintaining health and safety standards is described in detail in a report on the Bureau of Mines Haldane gas-analysis apparatus, just published by the Bureau of Mines, Department of the Interior.

Gas analysis is of fundamental importance in the determination and control of health and explosion hazards, and for many other purposes. The Bureau of Mines has made thousands of gas analyses with its modification of the Haldane-type gas-analysis apparatus in studies and surveys to improve health and safety as well as efficiency in the mining and mineral industries.

The chief advantages of the Haldane apparatus are the accuracy and precision attainable in determining carbon dioxide, combustible gases, and oxygen, state L. B. Berger and H. H. Schrenk, authors of the report. Many types of gas mixtures may be analyzed with an accuracy and precision of 0.02 to 0.03 in percentage composition. In many instances this degree of accuracy is essential in determination of minor constituents. The design of the apparatus places certain limitations on the range of concentrations of gases that may be determined.

The principles of gas volumetric analysis as applied in the Haldane apparatus are described and the factors that affect the accuracy of analysis are discussed. As the quality of results obtained in gas analysis is largely dependent on perfection of technique, the analytical procedure is presented in such manner that the novice gas analyst may proceed step-by-step in familiarizing himself with the technique of operation. Faults in manipulation that are likely to produce erroneous analytical results are stressed. Calculations that are applied to analytical data are explained and illustrated by examples. General comments on the use of the apparatus and instructions for its maintenance are included. Difficulties commonly encountered and their possible causes are presented in tabular form. An appendix contains a tabulation of gas properties pertinent to gas analysis.

Copies of this report, Information Circular 7017, "Bureau of Mines Haldane Gas-Analysis Apparatus," may be obtained from the Bureau of Mines, Washington, D. C.

Petroleum Institute Names Public Relations Committee

APPOINTMENT of W. S. S. Rodgers, of The Texas Company, New York, as chairman of the American Petroleum Institute's newly-organized Committee on Public Relations was announced recently by Institute President Axtell J. Byles. Rodgers, who is president of The Texas Company, will serve also as chairman of the Public Relations Steering Committee, the first of a number of sub-committees to be appointed from membership in the general committee and from various branches of the industry.

The new committee, which already comprises 27 members and is to be enlarged, replaces the Public Relations Advisory Committee, which has functioned with limited membership and scope of activities for a number of years. Plans contemplate the appointment of sub-committees representative of every active branch of the industry.

The first meeting of the Committee on Public Relations has been scheduled

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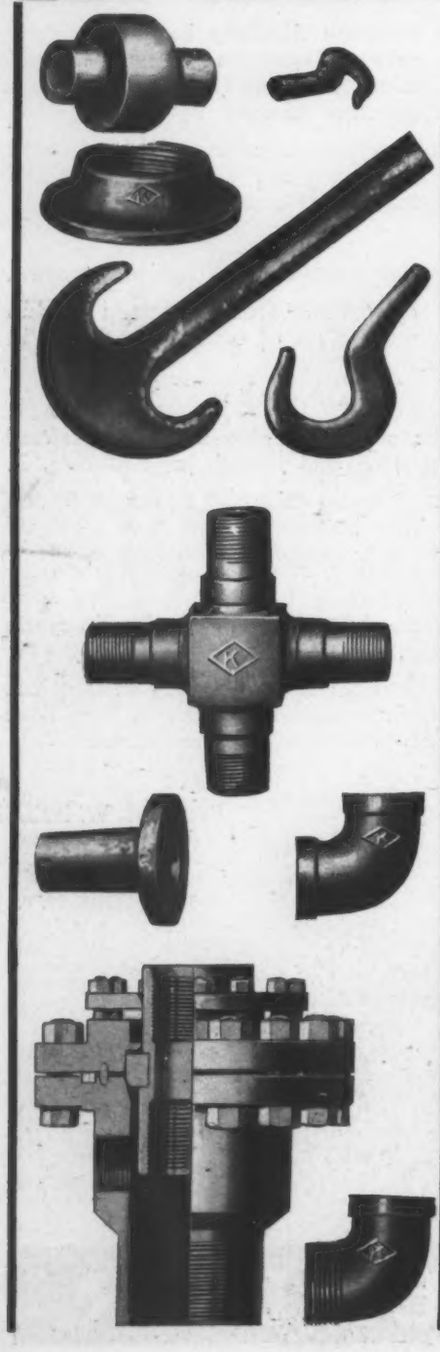

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Kropp further serves the oil industry by stocking over 500,000 flanges at all times: companion, boiler, reducing, blind and other flanges in all standard sizes, for immediate shipment. We will gladly mail copies of our Stock Flange List No. 125-A for your various departments.

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WHENEVER PIPING IS INVOLVED

for Monday, September 26, in the Stevens Hotel at Chicago. The meeting will be largely discussional in nature. Members of the committee so far appointed are:

Paul V. Barrett, The Ohio Oil Company, Findlay; Paul G. Blazer, Ashland Refining Company, Ashland, Kentucky; Ralph C. Champlin, Ethyl Gasoline Corporation, New York; James A. Dunn, Barnsdall Oil Company, New York; W. R. Francisco, Deep Rock Oil Corporation, Tulsa; A. C. Galbraith, Union Oil Company of California, Los Angeles, and D. W. Grant, Pennzoil Company, Oil City, Pennsylvania.

Also Eben Griffiths, Socony-Vacuum Oil Company, New York; Walter R. Haun, Lion Oil Refining Company, Eldorado, Arkansas; C. L. Henderson, Vickers Petroleum Company, Wichita, Kansas; C. C. Herndon, Skelly Oil Company, Tulsa; Allan Jackson, Standard Oil Company (Indiana), Chicago; Francis L. Jehle, Globe Oil & Refining Company, Wichita; Roy B. Jones, Panhandle Producing & Refining Company, Wichita Falls, Texas; R. C. Jopling, Phillips Petroleum Company, Bartlesville, Oklahoma, and E. B. Lyman, Standard Oil Company (New Jersey), New York.

Also Ray E. Miller, Hanlon-Buchanan, Inc., Tulsa; George D. Olds, Continental Oil Company, New York; H. F. Parsons, Tide Water Associated Oil Company, New York; Philip Patchin, Standard Oil Company of California, San Francisco; T. D. Peace, Shell Union Oil Corporation, New York; D. T. Pierce, Consolidated Oil Corporation, New York, and Richard Rollins, The Atlantic Refining Company, Philadelphia.

Also Paul Ryan, The Pure Oil Company, Chicago; H. A. Schramm, Kanotex Refining Company, Arkansas City, Kansas; George H. Shaw, Cities Service Company, New York; James A. Tanham, The Texas Company, New York, and W. K. Warren, Warren Petroleum Company, Tulsa.

The present membership of the Public Relations Steering Committee follows:

Northrop Clarey, Standard Oil Company (New Jersey); E. W. Hodges, Cities Service Oil Company, New York; T. D. Peace, Shell Union Oil Corporation, New York; D. T. Pierce, Consolidated Oil Company, New York; Conger Reynolds, Standard Oil Company (Indiana), Chicago, and J. C. Welliver, Sun Oil Company, Philadelphia.

Victor H. Scales, of the Institute staff, has been appointed secretary of the committees.

Committees Appointed for Next Houston Oil Show

PLANS for the 1939 Oil-World Exposition at Houston have been further advanced by the appointment of committees to handle the various departmental activities. The Exposition will be held April 24-29, 1939, but the actual work of the various committees will be started at once so that complete plans of each can be made well in advance and the work of the different departments coordinated most effectively.

The general Program Committee chairman is Joe Russell of Gulf Oil Corporation, and the Drilling and Production Committee chairman is George Corless of Humble Oil & Refining Company. Ed Lenzner, general manager of the exposition, will serve as assistant chairman of both, and the chairman of each will appoint necessary members to carry on the work.

The other committees are: Refinery Committee, with W. H. Curtin, W. H. Curtin & Company, chairman; Ed Lenzner, assistant chairman; O. E. Berg, Babcock & Wilcox Tube Company; M. N. Dannenbaum, M. N. Dannenbaum Company; R. L. Mallory, Brown Instrument Company; Joe Miller, Humble Oil & Refining Company; Joe Peddie, Maintenance Engineering Corporation; George Reid, Editor, The Refiner; J. L. Finley, Humble Oil & Refining Company; L. G. Marsh, Taylor Instrument Company; G. B. Lane, Foxboro Company; H. M. Stewart, Humble Oil & Refining Company.

Conference on Refinery Laboratory Procedures: K. H. Clough, W. H. Curtin & Company, sub-chairman; Dr. F. W. Jessen, Humble Oil & Refining Company; Fred W. Karl, Gulf Oil Corporation; R. C. Rich, Shell Petroleum Corporation; A. R. Rickards, Sinclair Refining Company; E. W. Gardner, The Texas Company; W. F. Fulton, United Gas Company.

Petroleum Safety Committee: J. J. Delahide, B. F. McDonald Company, chairman; Ed Lenzner, assistant chairman; R. B. Roaper, Humble Oil & Refining Company; C. A. Miller, The Texas Company; C. L. Hightower, United Gas System; P. E. Keegan, Shell Petroleum Corporation; F. P.

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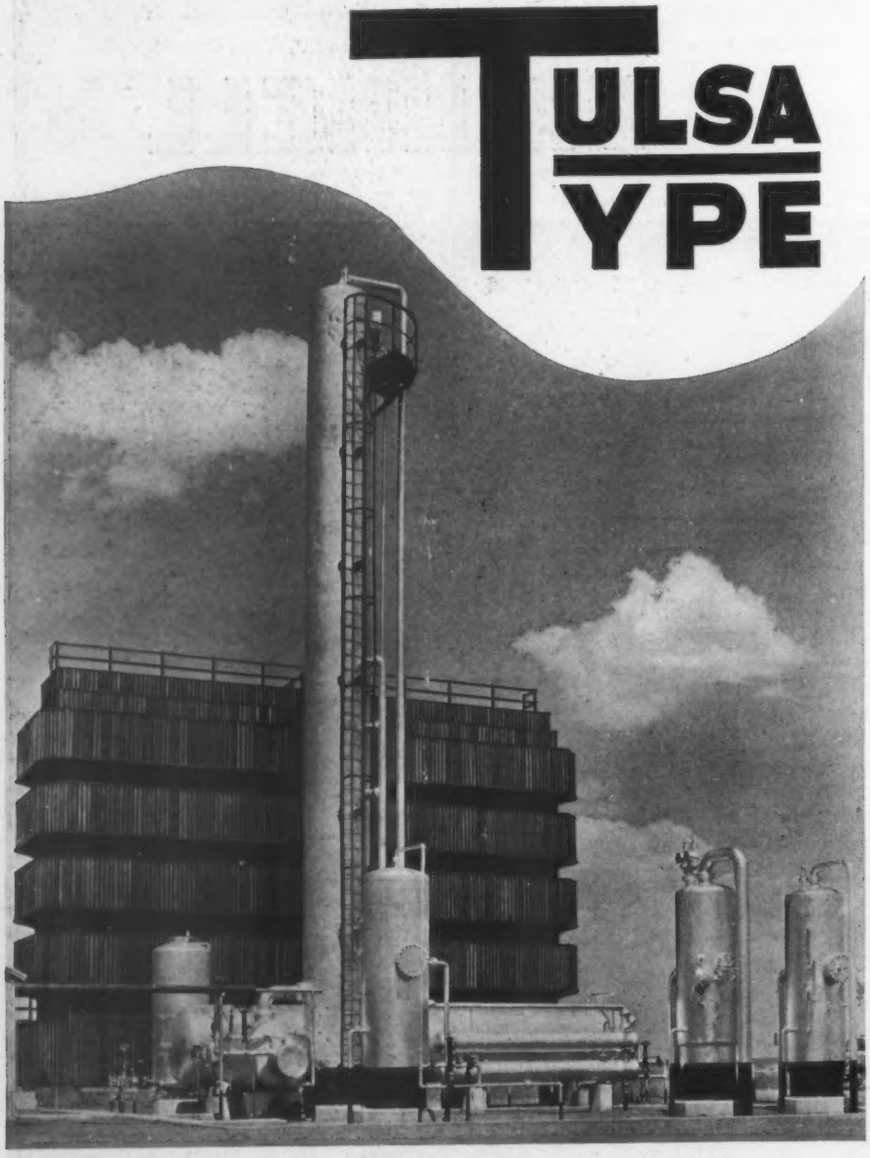

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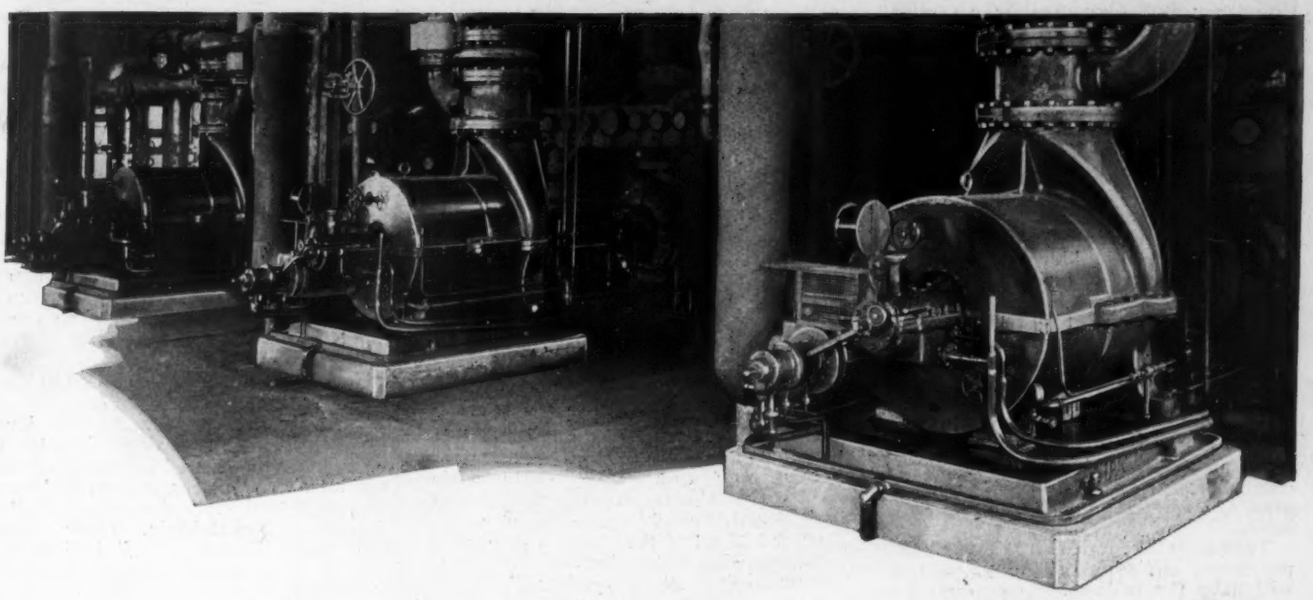

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Reliability is the watchword of a hot oil pump and its drive. And since this unit runs for long periods, handling a continuous stream, efficiency is also quite important.

Elliott steam turbines are becoming increasingly popular for driving centrifugal hot oil pumps. They have a solidly earned reputation for dependability. High standards of materials and workmanship, together with excellent engineering design, give them the all-around high quality demanded for this drive.

For all sorts of drives around the refinery, Elliott turbines bring the rugged, smooth-running, dependability so prized by refinery operators.

Elliott turbines are built in a complete range of sizes and types to suit all conditions and varieties of drives. Single-stage mechanical drive turbines are available for rating from 10-hp. up. Multi-stage turbines are built with characteristics to suit the drive. All-Elliott turbine-generator units are available in sizes up to 7500 kw.

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Entertainment Committee and Oil Men's Banquet Committee: Frank Carothers, Norvell-Wilder Supply Company, chairman; Ed Lenzner, assistant chairman; T. L. Fontaine, Humble Oil & Refining Company; O. S. Cummings, Houston Oil Company; S. T. Childress, Rio Bravo Oil Company; Robert J. Miller, Robert J. Miller Company; George O'Leary, Houston Oilfield Material Company.

Foreign Dinner Committee: R. L. Dudley, Gulf Publishing Company, chairman; Ed Lenzner, assistant chairman. Other members will be appointed later.

Transport Committee: Motor Transportation Division of Oil Companies will have the following members: Leo New, United Gas System, chairman; E. B. Tilley, Gulf Oil Corporation, vice chairman; Oscar Lynch, Humble Oil & Refining Company; Jack Parker, Transportation Equipment Company; T. G. Price, Shell Petroleum Corporation; Frank Nolan, The Texas Company; Alex Muncie, The Pure Oil Company; Lonnie Smith, Sun Oil Company.

All other committees, such as Export Committee, California Association Committee, Rocky Mountain Association Committee, Attendance Committee, will be appointed at a subsequent meeting.

Designers of Equipment Receive Awards

THE Jury of Award of the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, after judging thousands of papers submitted in the $200,000 Award Program, found that savings to industry by arc welding claimed by authors of papers aggregates $1,600,000,000. The jury's statement, released September 15 at the conclusion of its judging of the papers, follows:

"The Central Committee of the Jury of Award of the James F. Lincoln Arc Welding Foundation finds that the savings to industry by arc welding claimed by authors of papers aggregates $1,600,000,000. This figure is arrived at after discounting some very enthusiastic claims. It is an amazing figure and undoubtedly would have been much greater had all of the authors estimated gross savings from the application of arc welding to their products."

Altogether, 382 awards were made by the foundation. The amounts ranged from $101.75 for honorable mention to $13,941.33, the Grand Award. Recipients included engineers, designers, architects, production managers, superintendents, draftsmen, shop foremen, mechanics, inspectors, welding operators, welding supervisors, owners of businesses, college professors, high school instructors, students, and others. Subjects of studies in the 44 divisions of the program, represented practically every product and structure of industry.

In the oil industry, subjects of papers for which authors received awards were: Well casings, reconditioning pipe lines in service, an oil pump motor base, bubble trays, well drilling, a coking still shell, welding joints directly to drill pipe, new rotary machine, a wire line wall sampler, a production mast for well servicing rotary hose coupling and an oil field slush pump.

G. M. Stearns, district production engineer, Cities Service Oil Company, Russell, Kansas, received the largest award for a paper from the industry. His award was $2,543.88. His paper, "Arc Welded Well Casings," demonstrated that use of arc welding in running casing would have saved $637,000 for 5 percent of the oil wells completed in the United States in 1937.

An award of $712.28 in the petroleum machinery division went jointly to John F. Muller and G. C. Munoz, power transmission engineer and general manager, respectively, American Pulley Company, Philadelphia. Their paper, "Oil Pump Motor Base," indicated a possible gross saving to the industry of $16,000,000.

Award of $508.77 was received jointly by Phillip S. Ball and Justus O'Reilly, draftsman and assistant engineer respectively, Skelly Oil Company, El Dorado, Kansas. Their paper was "Arc

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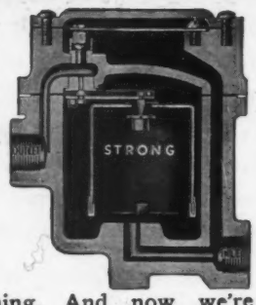

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Welded Trays for High Pressure Bubble Tower."

Award of $305.26 went jointly to S. Wm. Riley and George Heinish, design engineer and chief engineer, respectively, Star Drilling Machine Company, Akron, Ohio. The paper "Arc Welding Advances the Art of Well Drilling," shows weight reduction of 13,000 pounds by arc welded construction on a portable spudder drill, ability to use heavier tools and operate with less power, longer life, greater safety.

Award of $203.51 went to A. M. Elder, engineer maintenance department, Gulf Refining Company, Toledo, Ohio, for his paper, "Redesign of Coking Still Shell for Arc Welding." The paper shows a saving of $109,350 per year available by improved design with welding.

Award of $152.63 went jointly to G. W. Woods and R. S. Grant, engineers, Hughes Tool Company, Houston, Texas. A saving of $3,000,000 annually to the oil industry was shown available by their paper "Arc Welding Tool Joints Directly to Drill Pipe."

Honorable mention awards of $101.75 went to the following authors of papers on design of oil industry equipment: Fred C. King, Jr., draftsman, The National Supply Company, Torrance, California; L. W. Mosley, owner, Baker Oil Company, Huntington Park, California; R. H. Biggs, Midland, Texas; Joseph W. Gasper, designer, Maine Machine Works, Ltd., Gardena, California; jointly to W. C. Russell and L. W. Stahl, superintendent structural division, and chief engineer, mechanical division, Emsco Derrick and Equipment Company, Los Angeles, California and Houston, Texas; and R. E. Hughes, district foreman, Standard Oil Company of Louisiana, Oxford, Louisiana.

The grand award of the foundation's program went to Mr. and Mrs. A. E. Gibson, president and stockholder, respectively, of the Wellman Engineering Company, Cleveland, Ohio. The authors jointly received $13,941.33. Their paper is an outstanding treatise on all the elements required to assure the business and technical success of all users of welding throughout industry.

The foundation's award program, which began 18 months ago, was judged by 31 engineering authorities from leading universities and colleges throughout the country, and has been hailed by leaders in science, education and industry as a valuable contribution to industrial progress in America.

▼ PLANT ACTIVITIES ▼

Distillation: Standard Oil Company of California has under construction an 18,000-barrel crude distillation unit at its Richmond refinery. It is being so designed that it will premit joint operation with a twin-unit contemplated for future erection.

Treating: The Texas Company of California, Los Angeles, is installing a 5000-barrel Stratcold cold acid treating plant, licensed by Stratford Engineering Corporation at reported cost of $250,000. Contract to Bechtel-McCone & Parsons Company.

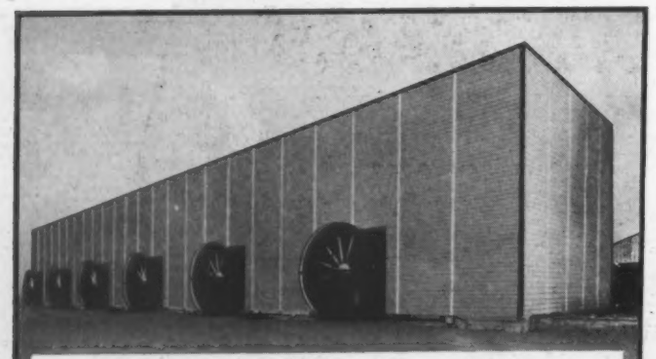
Cracking: Root Refining Company, El Dorado, Arkansas, is reported installing a new cracking unit.

Dewaxing Plant: Sinclair Refining Company, Wellsville, New York, has awarded contract to Lummus Company for construction of a modern dewaxing plant to replace the system destroyed by fire last July. The new unit is to be completed about February 1, 1939.

Gas Purification: Sun Oil Company, Philadelphia, has given contracts for two Koppers phenolate plants for the purification of refinery still gases, with contract to Koppers Company's Engineering and Construction Division. A plant using a two-stage system and with a capacity of 10,000,000 cubic feet of gas per day is to be erected at the company's Toledo refinery. A single-stage plant, to be provided for the Marcus Hook refinery, will have daily capacity of 12,000,000 cubic feet a day.

Repairs: Barnsdall Oil Corporation, Odessa, Texas, suffered major damage from explosion and fire early last month, and is repairing the damaged plant to resume operations.

Cracking Unit: Mohawk Petroleum Company, Bakersfield, California, is re-



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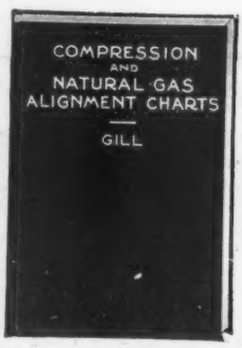
COMPRESSION AND NATURAL GAS ALIGNMENT CHARTS

By THOMAS T. GILL



The charts in this book have been found useful in solving field problems arising in connection with the measurement, compression and transmission of natural gas, and in the manufacture of natural or casinghead gas. As many of the formulas in common use in natural gas operations are of an impirical nature, with constants that must be evaluated under varying conditions, it will be found that alignment charts are sufficiently accurate for nearly all purposes except for metering large quantities of gas, and here they serve as an excellent check on other calculations. Contains 41 charts, 65 problems. Price $3.50 Postpaid.

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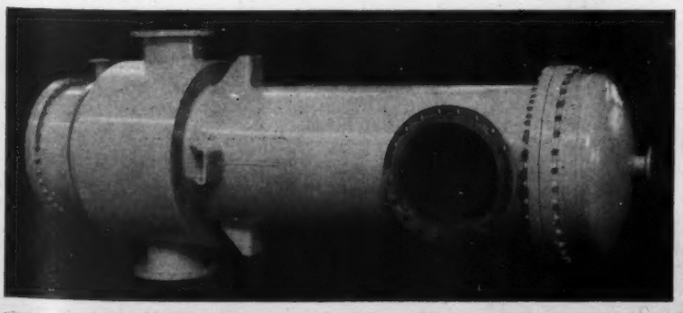

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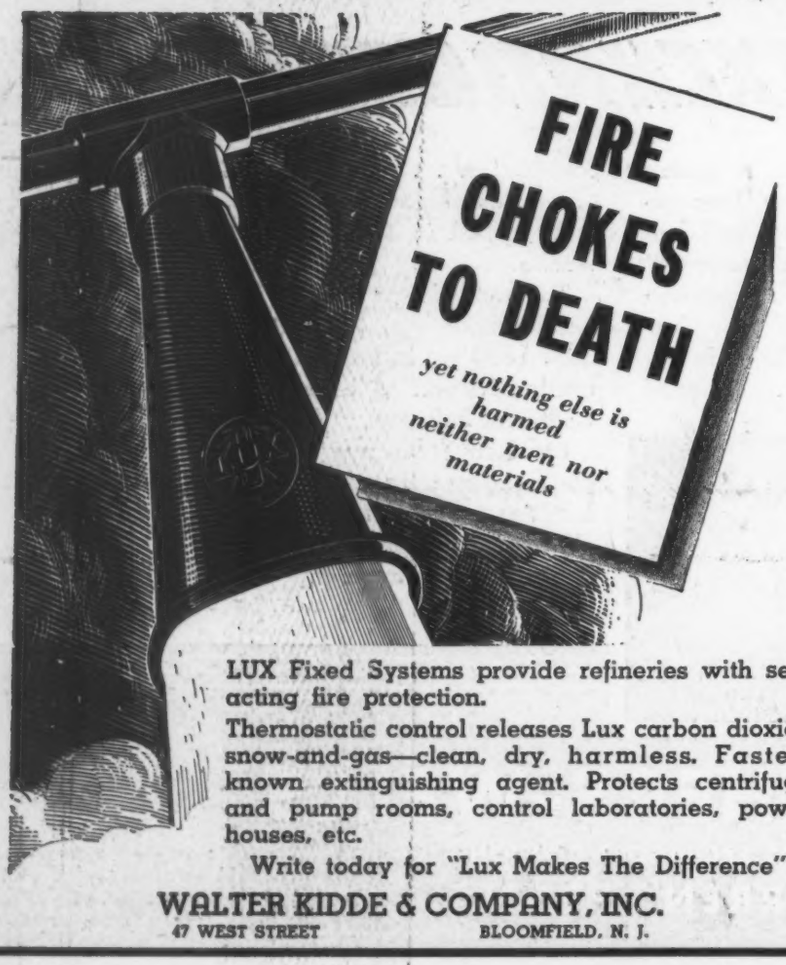

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ported planning to start construction of a new 1000-barrel Dubbs cracking unit.

Improvements: Arkansas Fuel Oil Company, Shreveport, Louisiana, is going ahead with its plans for construction of a combination skimming-cracking-polymerization installation to cost around $1,500,000.

Distillation: Ashland Refining Company, Catlettsburg, Kentucky, is completing construction of a 7000-barrel combination atmospheric-vacuum distillation unit and is to begin operations next month.

Refinery: Allied Oil Company of Illinois, St. Elmo, Illinois, is completing a 3500-barrel skimming plant to operate on Illinois crudes.

Refineries: McColl Frontenac Oil Company, now controlled by The Texas Company, is said to be making investigations toward the establishment of two refineries, one at Regina, Saskatchewan, and another of 2000 barrels capacity at Calgary, Alberta, Canada.

Lube Plant: Mid-Continent Petroleum Corporation is reported planning erection of two newly developed processes developed by company engineers for the production of lubricating oils at West Tulsa, Oklahoma. If the two new units are added, the total expenditure at the refinery, together with the regular repair work and reconditioning each year, would total around $1,000,000. Reports state the units will be a propane deasphaltizing plant and treating unit.

Refinery: Crown Oil & Refining Company, Torrance, California, is reported building a combination oil-cleaning and topping plant on Carson Avenue, in the Torrance field, using a process especially designed for processing Torrance crudes by E. E. Peveto, who heads the concern.

Repairs: Socony-Vacuum Oil Company, Paulsboro, New Jersey, is to repair damage to its centrifugal dewaxing plant which was virtually destroyed by fire late in August with damages reported at $200,000.

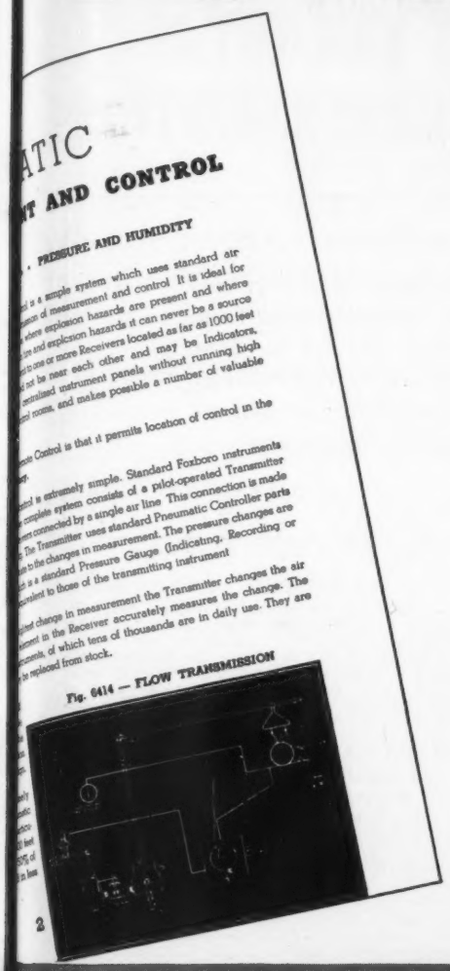
Refinery: British-American Oil Company has started construction of a new refinery at East Calgary, Alberta Canada. The plant is to be completed in May, 1939, and erected at a reported cost of $1,350,000.

Treating: Gulf Oil Corporation, Girard Point, Philadelphia, has started construction of an 8250-barrel Stratcold acid treating plant, purchased from Stratford Engineering Corporation. A 12,000-barrel Stratcold plant was recently completed for the same company at Port Arthur, Texas.

American Locomotive Company announced that its arrangement with the Gyro Process Company, whereunder it acted as exclusive agent for the sale of licenses licensing the Gyro cracking process, has been terminated. This exclusive agency, which was originally granted to Alco Products, Inc., a subsidiary of American Locomotive Company, has, since the take-over of the assets of said subsidiary, been conducted by the Alco Products Division of the American Locomotive Company.

Alco Products Division of the American Locomotive Company will now supply, in addition to its regular line of refinery equipment, any and all types of petroleum cracking equipment.

TO TRANSMIT measurements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quivalent to those of the transmitting instrument

ntinuous change in measurement the Transmitter changes the air
essure in the Receiver accurately measures the change. The
ruments, of which tens of thousands are in daily use. They are
can be replaced from stock.

Fig. 6414 — FLOW TRANSMISSION

2

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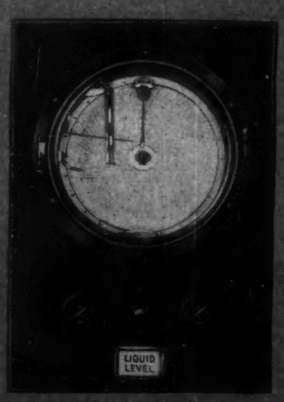

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The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Chemical and Physical Data

Heat of Combustion of Isoprene, R. S. JESSUP, *J. Research Natl. Bur. Standards* **20** (1938) pp. 589-97.

The heat of combustion of isoprene was measured in a bomb calorimeter calibrated with benzoic acid. The value 3156.9 ± 1.6 international kilojoules per mol. was obtained for the heat of combustion of liquid isoprene at 25° C. and 1 atmosphere pressure, the products of combustion being liquid water and gaseous carbon dioxide. The heat of vaporization of isoprene is considered to be 25.9 international kilojoules per mol.

Measuring Thermal Conductivity of Liquids, H. PFRIEM, *Z. Ver. deut. Ing.* **82** (1938) pp. 71-2.

A method for determining the thermal conductivity of liquids that avoids errors resulting from heat loss by convection currents is described. A fine wire stretched vertically in the liquid is heated electrically. The form of the resultant variable cylindrical temperature field depends on the thermal characteristics of the liquid. The theory of the method, and formulae for calculating the result, are given.

Thermal Conductivity of Gaseous Hydrocarbons and Their Atomic Polarization, R. DELAPLACE, *Compt. rend.* **206** (1938) pp. 1646-7.

The apparent anomaly in the order of the thermal conductivity of hydrocarbons, e.g., normal butane before iso-butane, but iso-butylene before normal butylene, is the same as that in their atomic polarizations. It is therefore inferred that the conductivity depends on the dynamic structure of the molecule.

Approximate Molecular Weights of Higher Hydrocarbon Fractions, F. A. LUCY, *Ind. & Eng. Chem.* **30** (1938) p. 959.

The author measured the boiling point of three hydrocarbon oils in the range C_{18} to C_{21}. Reference is made to work of Mair and Willingham, giving the boiling points at 1 mm. for a number of lubricating oil fractions from C_{27} to C_{39}. Both sets of data are fitted well by an equation, $T = 111.3n^{0.4896}$ in which, for the author's data, T is the uncorrected distilling temperature in °K at 1 mm., and n is the number of carbon atoms per molecule. In terms of molecular weight the equation is, $M = (T/35)^{2.376}$.

Activation Energy of Diene Association Reactions, M. G. EVANS AND E. WARHURST, *Trans. Faraday Soc.* **34** (1938) pp. 614-24.

The activation energies of diene association reactions were calculated (a) by the diabatic method and (b) by treating the system as a 6-electron problem. Results of method (b) agree with the experimental values, but the use of method (a) leads to values that are much higher. This is attributed to the neglect in method (a) of the nondiagonal term in the secular equation. The effective groups substituted in the reacting molecules may change the activation energy of association by the effect upon the "electron affinities" of neighboring carbon atoms. The abnormal temperature-independent factors of these reactions can be explained by the loss of rotational degrees of freedom as a result of the association. As an example, the reaction of ethylene and butadiene to give cyclohexene is considered.

Chemical Compositions and Reactions

The Chemistry of Petroleum—Past and Present, DR. J. VON BRAUN, *Jour. Inst. Pet. Tech.* **24** (1938) pp. 393-406.

The author reviews the chemistry of petroleum, including the identification of the individual components of petroleum, separation by fractionation, by cooling, and by selective solubility, and by adsorption, analytical procedure as directed toward the identification of the components of petroleum, the naphthenic acid components and their peculiar significance, and the sulphur and nitrogen containing compounds. The reactions of the substances of which petroleum is composed are briefly considered, including decomposition, polymerization, hydrogenation, and dehydrogenation, and catalysis. The application of chemical knowledge to the technology of the industry is briefly considered.

The Synthesis of Disubstituted Acetylenes, J. R. JOHNSON, A. M. SCHWARTZ, AND T. L. JACOBS, *Jour. Am. Chem. Soc.* **60** (1938) pp. 1882-4.

A study was made of the alkylation of metallic derivatives of monosubstituted acetylenes. The action of alkyl p-toluenesulfonates on the sodium or bromomagnesium derivatives of alkyl or arylacetylenes has been found to be a satisfactory procedure for the preparation of a variety of disubstituted acetylenes.

The Catalytic Interaction of Hydrogen and Deuterium with Ethylene and Deuteroethylenes on Copper, G. JORIS, H. S. TAYLOR, AND J. C. JUNGERS, *Jour. Am. Chem. Soc.* **60** (1938) pp. 1982-6.

The rates of addition of hydrogen and of deuterium to ethylene, ethylene-d_2 and ethylene-d_4 on active copper catalysts have been studied in the temperature range —20 to +40°C. The addition of deuterium occurs at a rate approximately one-half that of hydrogen on several ethylenes. Initially, on catalysts of high activity, no differences are observed in the rates of hydrogenation of the several ethylenes. With decreasing activity of the catalyst, resulting from poisoning, small differences in the rates of hydrogenation of the ethylenes are observed, the more highly deuterized ethylenes reacting more rapidly. The apparent activation energies of these reactions average 11.5 kg. cal. in the temperature range studied.

Maleic Acid Production—Vapor Phase Oxidation of Five-Carbon Olefinic Acids, W. L. FAITH AND M. F. YANTZI, *Jour. Am. Chem. Soc.* **60** (1938) pp. 1988-9.

As a contribution to the general subject of the catalytic vapor phase oxidation of the olefin hydrocarbons the authors studied the catalytic oxidation of the five-carbon olefinic acids. A vanadium pentoxide catalyst was used. 2-Pentenoic acid was oxidized to maleic acid with a maximum conversion of 38.8%. 3-Pentenoic acid yielded maleic acid with a maximum conversion of 42.5%. Tiglic acid yielded only carbon dioxide and unidentified acids and aldehydes.

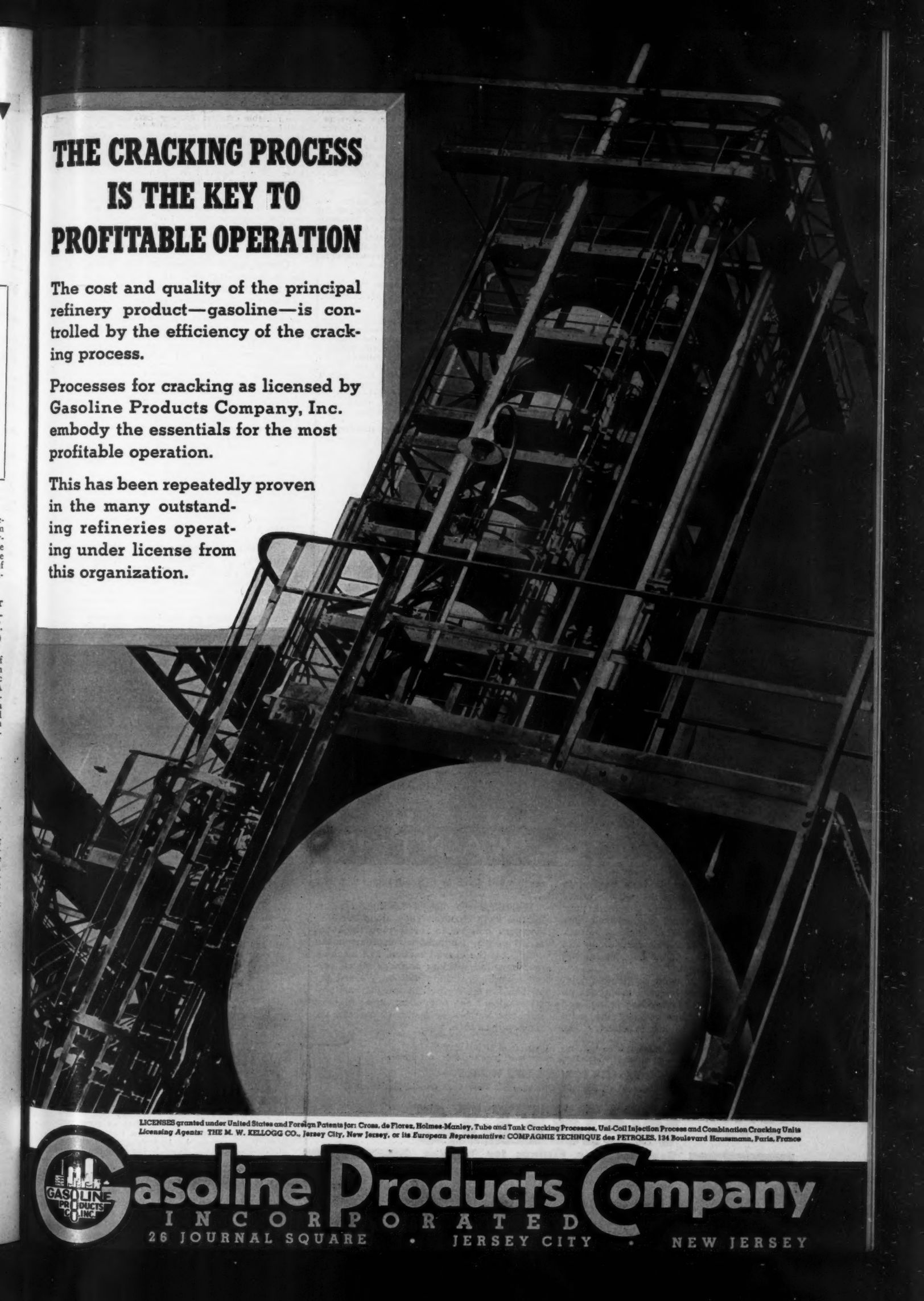
Manufacture: Processes and Plant

Heat Transfer Coefficients in Staggered Tube Banks, C. C. WINDING, *Ind. & Eng. Chem.* **30** (1938) pp. 942-7.

The heat transfer coefficients for air flowing over staggered banks of round, oval, and streamline steam-heated tubes are given. Streamline tubes should give a lower pressure drop through the tube bank, but the data show that this advantage is offset by lower coefficients of heat transfer in all rows except the first and second. Oval tubes give definitely lower rates of heat transfer than either of the other two shapes. The data secured for round tubes are compared with previous data and the various relationships that have been proposed to correlate the air film coefficients with the variables influencing the rates of heat transfer. For a constant film temperature the relation of thermal conductance and mass velocity has been expressed by the equation $h = aG^n$, where a and n are constants. This type of equation does not fit the experimental data and does not agree with previous data. The author states that the linear relationship found between thermal conductivity and mass velocity has not been expressed as a definite mathematical equation because many more data are needed over a wider range of variables involved before this can be done with any degree of certainty.

Condensation of Mixed Vapors, J. L. WALLACE AND A. W. DAVISON, *Ind. & Eng. Chem.* **30** (1938) pp. 948-53.

Although information on heat transfer film coefficients for condensing vapors of single substances is quite complete, there is little information available on film coefficients for condensa-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tion of mixtures of two or more condensable components. Such publications as are available are briefly reviewed. The apparatus used in the work, and the procedure in securing the data, are described. Film coefficients of heat transfer are presented for condensation from the mixed vapor system ethanol-water outside a horizontal tube at low condensing water temperatures. Results are given for variation of the coefficient with velocity of the cooling water and with composition of the mixed vapor, and the nature of the temperature gradients and composition is shown. Data are given for the relation between the composition of the vapor and that of the condensate. Differences between actual and apparent film coefficients are demonstrated. For pure benzene and toluene the film coefficients deviate but slightly from the Nusselt value.

Cleaning Up Refinery Gases, An Editorial Staff Report, *Chem. & Met. Engr.* 45 (1938) pp. 416-7.

The production of polymer gasoline, liquefied gases, and various organic chemicals from light hydrocarbon gases, has made the removal of hydrogen sulphide from these raw material gases a matter of increasing importance. The article briefly describes the Alkacid and Claus process of I. G. Farbenindustrie, the sodium phenolate process of the Koppers Company, the Shell phosphate process, and the Girbotol process. Some data on each process are given, with brief mention of commercial application.

Polymerization and Its Economics, W. A. KOEHLER, *Chem. & Met. Engr.* 45 (1938) pp. 412-15.

The catalytic polymerization process of the Universal Oil Products Company, and the Unitary thermal polymerization process of the Polymerization Process Corporation, are reviewed and described. Photographs and flow sheets are given, together with some data on results, and a bibliography of previous publications.

The Properties of Spirits Produced by the Hydrogenation-Cracking of Low-Temperature Tar, J. H. CARLILE, C. M. CAWLEY, AND C. C. HALL, *Jour. Soc. Chem. Ind.* 57 (1938) pp. 240-2.

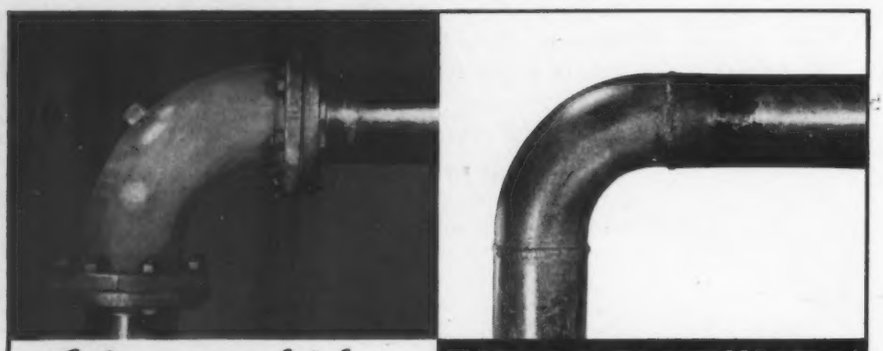
In previous work it was found that the chemical composition of the products obtained by the hydrogenation-cracking of low-temperature tar could be varied greatly according to the nature of the catalyst employed. Thus, when a pelleted molybdenum sulphide catalyst was used, the spirit formed contained 48% by weight of paraffin hydrocarbons, while that from a supported molybdenum sulphide catalyst contained only 7%. In continuing this work, other properties of the spirits have been determined and are recorded in the present paper. The specific gravity of the spirit may be varied from 0.73 to 0.81, and the proportion boiling below 100° C. from 19% to more than 50% by volume, without greatly affecting the octane number of the spirit, which is normally about 70. The yield of spirits by complete conversion of the tar is usually between 101 and 105% by volume.

Cresol as a Solvent in the Refining of Lubricating Oil, H. SUIDA AND H. POLL, *Petroleum* 34 (1938) pp. 1-14.

Recent work on solvent refining is briefly reviewed. The term selectivity as applied to the solvent should be restricted to denoting the quality of raffinate as distinct from the yield. Anhyd. cresol is more selective than phenol, or any other solvent used for oils in practice except nitrobenzene. The yield of raffinate depends upon the temperature of separation. The properties of commercial cresol are given, and tables are presented showing the effect of adding water to phenol and to cresol as regards the effect on the quality and yield of raffinate. The system oil-cresol-water behaves quite differently from the system oil-phenol-water, and has properties much more adapted to the solvent treating of oil. A two-stage process involving anhydrous and aqueous cresol can be used. This process is improved by addition of 25-35% of nitrobenzene in the sense that the layers separate more easily and the quality of the second or aqueous raffinate is better. The S.N.P. process using this method is described, and a semi-commercial plant is shown in illustrations. Tables giving yields and analytical data typical of the process as applied to oils of different origins are given.

Chemical Trends in the Petroleum Industry, P. K. FROLICH, *Ind. & Eng. Chem.* 30 (1938) pp. 916-22.

The author discusses and interprets the achievements that most clearly illustrate and typify the chemist's contribution to the present-day petroleum industry. Cracking and destructive hydrogenation are first briefly discussed, because these operations provide the basis for much that has been done recently from a chemical standpoint. The gasoline industry is now entering into a fourth phase with the production of synthetic motor fuels. Polymerization, alkylation, isomerization, synthesis of branched chain ethers, and use of tetraethyllead are briefly discussed. In connection with lubricating oil, the subjects of viscosity index, solvent extraction, production of synthetic lubricants, viscosity index improvers, pour point depressants, and inhibitors and oiliness additions are all considered briefly. The possibility of using petroleum hydrocarbons as raw material in chemical syntheses suggested itself at the time when unsaturated compounds of high degree of reactivity began to be available in large quantities as a result of the widespread adoption of cracking to increase gasoline production. From a modest beginning some fifteen years ago an important new industry has been developed that is now undergoing rapid expansion. Among the products being manufactured on a large scale from the hydrocarbons of lower molecular weight are ethyl alcohol, isopropyl alcohol, the secondary alcohols ranging from butyl up to heptyl or even octyl, and some tertiary alcohols. Esters are produced from the primary and secondary alcohols, and the secondary alcohols are converted to ketones by catalytic dehydrogenation. By the aid of the chlorhydrin reaction, glycols are obtained from the lower olefins, and alkyl chlorides are made by various methods. Naphthenic acids and mercaptans can now be recovered in larger quantities than existing markets can absorb. Nitrogen bases and alkyl phenols from petroleum are rapidly becoming available. Such secondary products as solvents, wetting agent, detergents, emulsifiers, flotation agents, plasticizers, etc., are now being made. Petroleum hydrocarbons have long resisted efforts to convert them economically into useful products by oxidation. The difficulty is that the primary reaction products are more susceptible to oxidation than is the hydrocarbon feed stock, and for this reason the reaction cannot be conveniently stopped at an early stage. However, these difficulties are being overcome, and methods for the production of fatty acids, dibasic acids, and olefin oxide or glycol, give promise of success. Recent work on chlorination has resulted in the discovery that conditions can be found that favor substitutive chlorination in the case of olefins. In this way it is possible to produce allyl chloride from propylene and methallyl chloride from isbutylene. Both of these compounds are useful intermediates for other products. For example, by hydrolysis, allyl chloride yields allyl alcohol. Considering that the United



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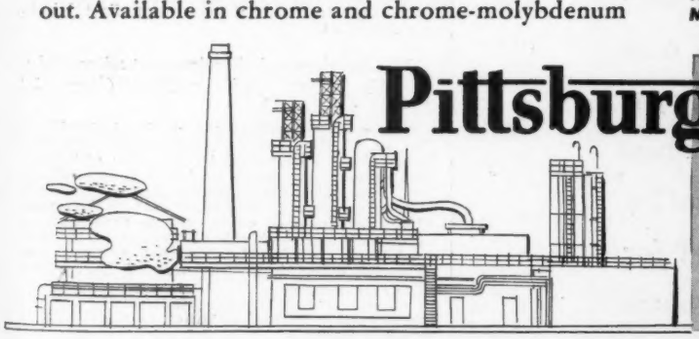

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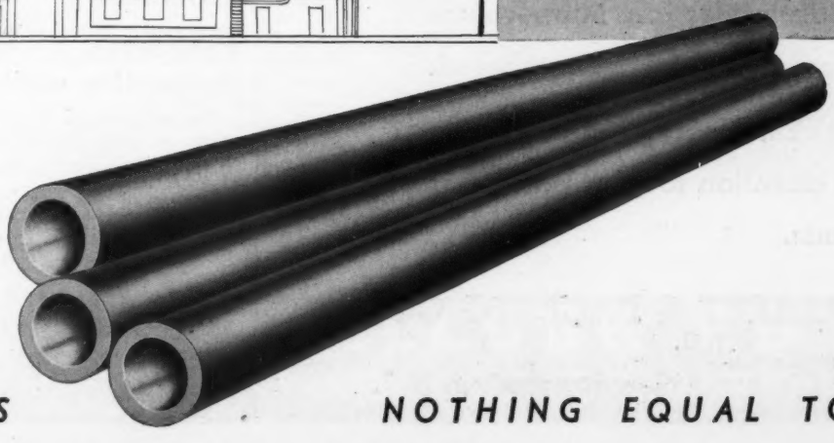

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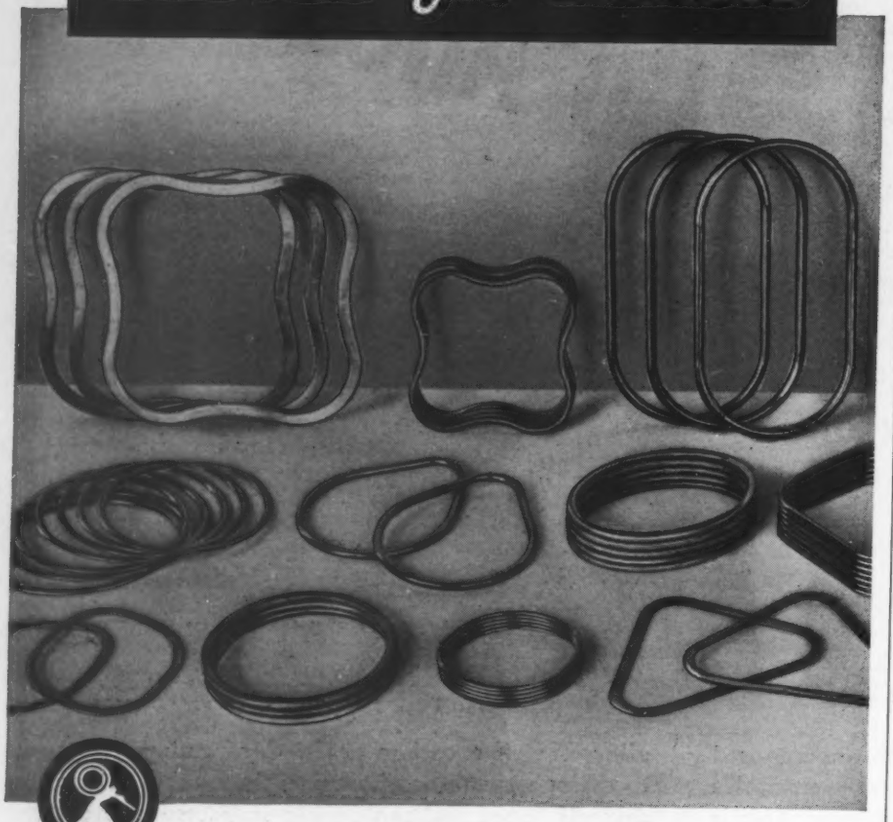

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States is the world's leading producer of synthetic resins, it is particularly significant that the petroleum industry is capable of supplying raw materials and intermediates for the manufacture of a variety of resins and plastics. In the light of recent developments, this field promises to furnish an outlet for petroleum products on a large scale. The activities in this direction are briefly summarized. Although the author's review is necessarily brief, it is believed that it will be found most helpful in gaining a perspective as to what is being accomplished in the application of chemistry to petroleum derivatives as raw materials.

Lubricating Greases: Their Manufacture and Use, E. N. KLEMGARD, pp. 873. New York, Reinhold Publishing Corporation, Chapman and Hall, Ltd., London. 75s. Od. net.

The present volume of nearly 900 pages is over five times the size of the original 1927 edition. The changes in the work are indicative of the demand for more highly scientific information in this field of work. The manufacture of lubricating greases is rapidly yielding to modern methods of organized investigation and control. It appeared some time ago that greases would not retain their position as lubricants of important machinery. This has, however, not proved to be true. Greases of various types are being used in ever increasing quantities for a great variety of lubricating purposes. As a result, the new edition of Klemgard is particularly valuable. The book is divided into 14 chapters. The first three are devoted to the nature of greases, the theory of manufacture, and description of the raw materials used. The chapters on calcium and sodium base greases occupy nearly half of the book. These are particularly valuable. The sections on aluminum, lead, and other metallic base greases, and on organic and inorganic lubricants and special lubricating compounds, are up-to-date and interesting. The book contains numerous references to the technical and patent literature. and many manufacturing formulas or comments upon manufacturing methods. The book is no mere compilation of abstracts and materials, but is obviously critically arranged by one who is an expert in his subject.

Beginnings of the Helium Industry, H. P. CADY, *Ind. & Eng. Chem.* **30** (1938) pp. 845-7.

The history of the development of the commercial production of helium in this country is given by Professor Cady, who has been intimately associated with the work since the early 1900's. As a result of the early work it was concluded that helium is present in every gas that comes from the earth, as is to be expected from the equally universal distribution of radioactive matter and the well-established nature of the X-rays as positively charged atoms of helium, needing only to add two electrons to become the gas, helium. As a result of the examination of many samples, Cady and McFarland were able to prepare isohelium lines on maps of western producing areas. The wartime work and operation connected with the plant at Fort Worth are described.

Production of Helium at Amarillo, C. W. SEIBEL, *Ind. & Eng. Chem.* **30** (1938) pp. 848-52.

The author describes the work of the U. S. Bureau of Mines at Fort Worth and Amarillo, Texas, for the commercial production of helium. The process now used at Amarillo is outlined. The plant has produced over eighty million cubic feet at an average operating cost of less than $12.00 per thousand cubic feet. At times of high production, and with sale of the residue gas, the production cost has been as low as $5.00 per thousand cubic feet. The uses of helium are briefly reviewed.

Products: Properties and Utilization

Importance of Polymerization Processes in Gum Formation in Gasolines, G. R. SCHULTZE, *Oel u. Kohle,* **14** (1938) pp. 113-7.

It is found that polymerization is important in gum formation. Peroxides have been considered as a primary product in the formation of gum. However, polymerization can take place in the absence of air or without peroxide formation. The polymerization of dicyclopentadiene was studied. This forms the dimer, which in turn decomposes to the monomer at higher temperatures. The synthesis and decomposition of the dimer were investigated over a pressure range 180-510 mm. mercury and within the temperature range 132-182°C. The heat of activation for the polymerization was found to be 16,900 calories ± 3%. All diolefines are important from the standpoint of gum formation, since

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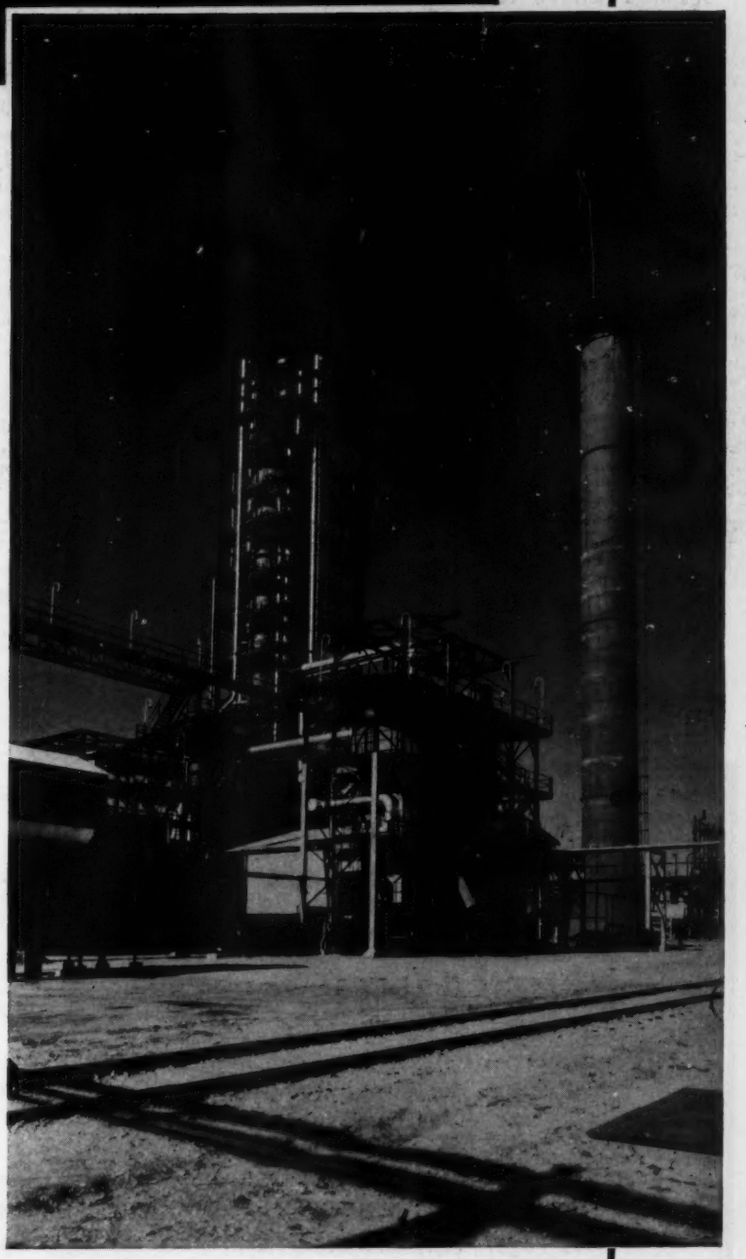

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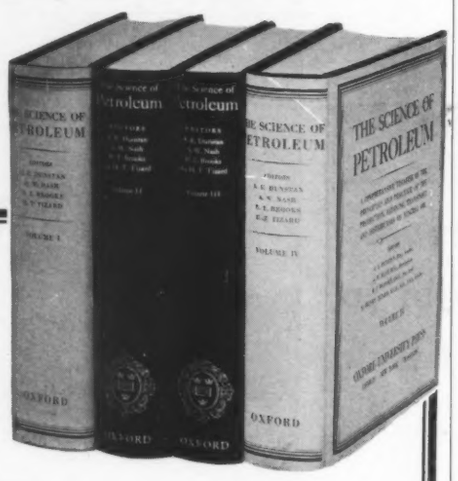

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they react either with themselves or with other substances. Gum tests depending upon volatilization do not show the presence of cyclopentadiene except at high concentrations, as it evaporates with the light fractions. It is concluded that the apparent anomalous results of different gum tests can in many cases be explained if the volatility of the gum-forming compounds is taken into account.

A Mollier Diagram for the Internal-Combustion Engine, H. C. HOTTEL AND J. E. EBERHARDT, *Chem. Revs.* **21** (1937) pp. 438-60.

Quantitative calculations of the effect of flame propagation and of piston movement on the temperatures attained in the various parts of an Otto-cycle engine charge during combustion are made relatively simple by the use of a Mollier diagram of the properties of the combustion products of octane and air. The authors apply the method to a consideration of the effect of spark advance on the temperature attained ahead of the flame front, and they conclude that the results are significant in studies of engine knock.

Sludge and Deposits in Turbine Oils, W. O. ANDREWS, *Jour. South African Institution of Engineers,* **36** (1938) pp. 158-62.

The products of partial oxidation of the oil are a principal cause for the formation of deposits in turbine oils. Oxidation occurs because of the high temperature to which the oil is exposed in service, and because of the aeration combined with rapid circulation. A sludge forms if the oil is of poor quality and if small quantities of water or steam get into the lubricating system. The sludge is a water-in-oil emulsion. The emulsion tendency of an oil increases with age. New oil separates more quickly from an emulsion. The rapidity of the separation is an indication of the quality of the oil. The "R. L. Emulsion Test" is based upon this idea. The test is described. Fresh oils may be subjected to an accelerated aging test by heating to 150°C. before receiving the de-emulsifying test. If there are no deposits after heating for 6 hours and the oil then separates from the emulsion at the rate of 50 mm. per hour, it may be considered a satisfactory turbine oil.

Ageing of Paraffinic and Naphthenic Mineral Oils, E. HAUS, *Oel u. Kohle,* **14** (1938) pp. 299-309.

A paraffinic and a naphthenic lubricating oil were aged by passing oxygen through them at 150-250°C. for different periods of time, and the asphalt and resins formed were separated by Poll's method. The rate of formation of resins at a given temperature was at first greater than that of asphalt, but later reached a constant value or passed through a maximum. The formation of asphalt increased progressively with time. Asphalt formation from paraffin oils showed an induction period. Both asphalt and resins form more rapidly at higher temperatures. Ultimate analyses and molecular weights of the oils, resins, and asphalts are tabulated, and the changes in ultimate composition, as well as composition as determined by Waterman's analysis. It is concluded that the resins form an intermediate stage in the production of asphalt, and that when asphalt separates from the oil as an insoluble precipitate it carries adsorbed resins with it.

Effect of Nitric Acid on the Ageing of Lubricating Oils in I. C. Engines, C. EHLERS, *Petrol. Z.* **34** (1938) No. (19), *Motorenbetrieb,* p. 2.

It is known that the residues, carbon and sludge from used oils often contain nitric acid, formed from the nitrogen of the air during combustion. In the present work it was attempted to determine whether the acid attacks metal parts, giving salts that increase friction, or whether its action on the oil is direct. Comparative oxidation tests were made using commercial motor oils of different qualities, using oxygen and a mixture of oxygen and N_2O_3 both with and without the presence of copper. The effect of N_2O_3 in the oxygen was to darken the oil and to give an actual precipitate that was insoluble in light gasoline. Study of the aged oils indicated that the oils themselves were vigorously attacked, and the source and original quality of the oils was of little significance if N_2O_3 was present. The chief effect of N_2O_3 was to increase carbon residue and sludge formation. If a residue or sludge from a used oil contains nitric acid the cause of the condition of the oil must not necessarily be attributed to the quality of the oil itself.

Asphalts and Allied Substances, H. ABRAHAM, Fourth Edition. pp. xxiv+1491. Chapman and Hall, Ltd., London, 1938. 60s. net.

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The
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work on asphalts and allied substances, the third edition of which was published in 1929 and reprinted in 1932. The progress made in the period since publication of the last edition has been covered in approximately 500 pages of additional matter. The previous arrangement of the text has not been materially changed, but has been expanded and brought up to date through addition of the new material. The book comprises 37 chapters, and the author has spared no effort to make the new edition as comprehensive as possible. An important improvement in the present volume is the section on testing methods. This has been entirely rewritten, and now constitutes about 28 percent of the entire work. All of the recognized standard methods are included, and also a number of others that have appeared in the literature and have been tested in the author's laboratory. The methods are numbered in accordance with the author's own system of classification, but the official designation of the A.S.T.M. or other standardizing bodies can be obtained from the list of references at the end of the volume. An extensive bibliography with comprehensive reference to patents occupies nearly 250 pages of the book. Also, the book will be found invaluable to those interested in this general subject, and it will be difficult to find any branch of the subject that has not been considered in a painstaking manner.

A New Type of Semimicro Fractionating Column, S. D. LESESNE AND H. L. LOCHTE, *Ind. & Eng. Chem., Anal. Ed.* **10** (1938) p. 450.

A column of high effectiveness for the distillation of small volumes of solution is illustrated. The column itself is a tube 15 inches long and 6 mm. inside diameter. A nichrome ribbon 4 mm. wide is suspended in the column and rotated at 1000 r.p.m. In tests on known systems the H.E.T.P. was approximately 4 inches when the rotating ribbon was not running, but only 1 inch with the ribbon rotating. That is, the 15-inch column gave the equivalent of 15 theoretical plates.

Determination of Organic Sulfur in Gas, C. W. WILSON AND W. A. KEMPER, *Ind. & Eng. Chem., Anal. Ed.* **10** (1938) pp. 418-9.

The method is an adaptation from the A.S.T.M. method for the determination of sulfur in motor fuels. Although rapid and convenient, the A.S.T.M. method has been found objectionable because any component of acid character absorbed by the sodium carbonate will be determined as sulfur, and the result will be too high. In the method proposed this objection is avoided by using standard barium chloride solution for the volumetric determination of sulfates with tetrahydroxyquinone indicator. The method can be used for the determination of sulfur in motor fuels, as well as for the determination of organic sulfur in gas.

Contribution to Viscosimetry, A. BONDI, *Petrol. Z.*, **34** (1938) No. 6 p. 1.

The viscosity-temperature coefficient of lubricating oils and asphaltic bitumens, and the viscosity of blended oils in relation to the components was studied. Viscosity pole-height (Vp) is regarded as the best measure of temperature susceptibility. The assumption that Vp is the same for all oils of the same origin was found to be unsound. For any given crude the Vp of fractions was found to increase as width of cut decreased. Vp is not a guide to the distribution of hydrocarbons in an oil, for viscosity is dependent on the stereometric structure of the molecules and not on their chemical composition. No relation exists between Vp and volatility. In the author's opinion, the lubricating value of an oil as gauged by friction losses is mechanical and can be expressed without reference to surface phenomena. The pressure coefficient is of more significance than temperature susceptibility; the former is sensitive to small additions of "dope," whereas the latter is not affected. This viewpoint permits explanation of the known effect of adding fatty acids to a lubricating oil.

Observations on the Mechanical Testing of Bituminous Road Mixtures, J. PH. PFEIFFER, *Jour. Soc. Chem. Ind.* **57** (1938) pp. 213-25.

The results of recent investigations have proved that the simple mechanical tests usually applied to solid materials are unsuitable for judging the value of bitumen-mineral aggregate mixtures for road building purposes. In a special method, based on the principles of soil mechanics, a test has been found in which the plastic nature of bituminous road mixes is fully taken into account. The theory underlying this so-called "cell test" is explained, and from a number of examples it is shown in what manner the various elements constituting the shearing resistance can be expressed and estimated in figures.

New Equipment for the Modern Plant

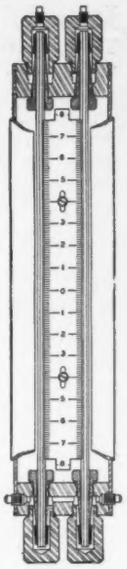
High-Pressure Manometer

DANIEL ORIFICE FITTING COMPANY

Daniel Orifice Fitting Company, Dept. 120-K, 3352 Union Pacific Avenue, Los Angeles, California, is introducing a new straight-tube high-pressure manometer.

The design of this new Wilcox Manometer, Patent No. 2,088,777, permits the use of straight tubes which are sealed positively against leakage by synthetic rubber sleeves, thus eliminating strain or stresses in the glass. The construction does away with stuffing boxes and provides a compensating seal under pressure.

Because there is no U-Bend and only the lightest contact between glass and metal parts, there is no distortion of the tubes when seal is made. Every part is easily accessible, impervious to gas, oil, gasoline, etc., and easily cleaned. If glass is accidentally broken, only one side need be replaced.



Wilcox Manometer

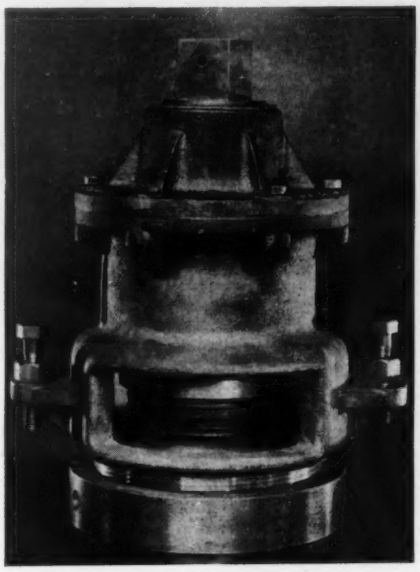
Tank Car Outlet Valve

GEORGE VALVE COMPANY

George Valve Company, Saegerstown, Pa., announces a new type of tank car outlet valve designed to overcome all of the major causes of valve failure and includes a number of other improvements.

Corrosion of the valve parts is obviated by the use of virgin bronze, eliminating freezing, and this bronze is used throughout to prevent corrosion by galvanic action. The presence of scale or other foreign matter between valve and face and seat is eliminated by sealing the face of the valve while it is open and by providing a wiping action which cleans the seat of scale every time the valve is opened. The two advantages are secured by the use of two neoprene parts, which are essentially rings surrounding the face of the valve disk when in the open position although the lower one is webbed across the base of the disk. Neoprene, du Pont's chloroprene rubber, was used for these rings because it was necessary to employ a resilient material which would resist deterioration from contact with chemicals and petroleum derivatives, the liquids commonly carried in tank cars.

The application of the neoprene rings has eliminated the practice of overforcing the valve. Since the seat is always clear of scale, it is not necessary to force the valve in order to close it tightly. However, the design includes another innovation which is planned to do away with breakage even though the workman uses unnecessary force.



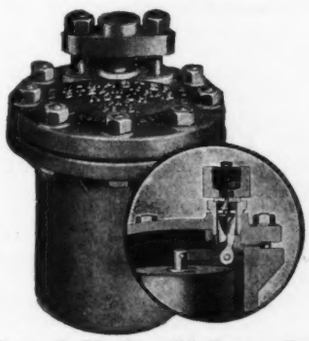
George Tank Car Outlet Valve.

The basic principles included in this design innovation are compression seating instead of grind seating, and a free-wheeling action. The application of compression seating makes the free-wheeling action possible, but it also eliminates scoring of the valve face, through the grinding action.

Steam Trap

KAYE & MACDONALD, INC.

Kaye & MacDonald, Inc., West Orange, New Jersey, is offering the new and improved K-Master modernized inverted-bucket steam trap in which several unusual features of design are incorporated, it is claimed. Soundness in principle, simplicity of design and ruggedness of parts are features stressed by the manufacturer.



Kaye & MacDonald Steam Trap

The valve assembly is such that the valve mechanism can be inspected without removing the cover. By merely lifting off the outlet cap the valve seat is exposed, thus permitting ready reversal or change. At the same time the valve itself can be changed or reversed by simply spreading the hinged jaws and lifting out the valve. By means of this external valve assembly, ground joints are used which eliminates the use of gaskets, pins, or threads and which affords no opportunity for concealed leaks. The fact that the valve and seat is reversible means double life and an extra valve and seat, ready for immediate use whenever the other side becomes worn. All vital parts are made of hardened stainless steel to protect against wear and corrosion. The valve action is quick and there is no wire drawing, it is said. These traps are made in all sizes from ½-inch to 2-inch and in pressures up to 600 pounds.

Wrench Set

J. H. WILLIAMS & CO.

J. H. Williams & Co., 75 Spring Street, New York City, has announced a new set of detachable "Supersockets" for use with hollow-screws. This set, composed of bits, parts and handles, is designed to replace the L shape wrenches of hex bar steel and provide greater speed and convenience in driving hollow-screws.

Williams Wrench Set

Set AL-101 contains 19 pieces; 10 bits for handling hollow (hex socket) set screws, ¼ to 1⅜-inch, and hollow cap screws, No. 8 to 1-inch. These bits have a knurled end for fast spinning of screws until they become tight enough to be turned with the handle, or driver. Also, 9 handles and parts, including 2 reversible "Superratchet" handles and Williams' new torque "Measurrench," No. B-21. The "Measurrench" provides an efficient tool for measuring right-hand turning torque and enables the operator to tighten hollow screws to the proper degree without danger of overload. Set is supplied in fitted steel case.

Furnace Controller

THE BROWN INSTRUMENT COMPANY

The Brown Instrument Company, Philadelphia, announces development of the AIR-o-LINE furnace pressure controller., which is applicable for controlling any pressure in the range from minus 5.0-inch H_2O to plus 5.0-inch H_2O.

The controller is essentially a sensitive, inverted-bell type draft indicator combined with the Brown AIR-o-LINE control unit. Automatic reset and fully adjustable throttling range

Brown Air-O-Line Indicating Pressure Controller.

prevents the furnace pressure from lining out at some point other than the control point and eliminates over-correcting and cycling.

This instrument has consistently held furnace pressures within plus or minus .002 inches of water on a scale span of 0.2 inches of water. Not only is it accurate but it is practically instantaneous in operation, as the pointer will move 10 percent of the total range in one second, and 100 percent of the total range in three seconds, the manufacturer states.

The AIR-o-LINE furnace pressure controller is adaptable to installation on all types of furnaces, stills, kilns, ovens and other similar equipment where very low differential or static pressure must be maintained.

Union Check Valve

YOUNGSTOWN SHEET & TUBE COMPANY

Youngstown Sheet & Tube Company announces a spring-controlled forged steel union check valve for the petroleum industry. Designed to handle full pipe capacity, the valve is built for up to 600 pounds steam working pressure or 2000 pounds cold working pressure.

The spring controls the opening and closing of the valve in accordance with the velocity of the flow yet is so designed that it is not affected by sudden fluctuations of flow or back pressure.

The valve has a hylastic vanadium cast steel body with tensile strength of 103,000 pounds per square inch, and poppet and seat of high temperature and corrosion-resisting bronze known as U. S. Navy Bronze 88-10&2. The spring is made of phosphor bronze and will retain its tension on temperatures up to 650°F. The valve can be used in any position, vertical, horizontal or upside down.

Poppet, seat and spring are heavily chrome plated to resist the corrosive action of crude oil and acids. Examination and replacement of poppet, seat and spring can be made without removing the valve from the line.

The union check is made in three sizes for 2-, 2½-, and 3-inch pipe and is furnished with either standard or handle bar nut.

Globe Valve

CRANE COMPANY

Crane Company, 836 South Michigan Avenue, Chicago, has designed a new, brass, globe valve (No. 237) for air installations where quick-opening, quick-closing, valves are needed. Among its features are an apron on the wheel to protect the upper part of the valve from rough handling and a brass screen in the union connection at the valve inlet to keep out foreign matter. It is made in ¾- and 1-inch sizes and is recommended for 150 pounds air working pressure. The composition disc can be quickly and easily renewed when necessary. A spring maintains a constant load on the stuffing box packing.

The valve has a non-rising stem which opens or closes in about a three-quarter turn. The stem rotates but does not rise, being held from vertical movement by the shoulder which rests between the bonnet and stuffing box. Turning the wheel raises or lowers the disc holder, which is held from rotary movement by two vertical guides, one on either side of the holder.

Explosion Proof Motor

LOUIS ALLIS COMPANY

Louis Allis Company, Milwaukee, Wisconsin, recently announced a complete new line of D.C. explosion-proof motors. The new line is said by the manufacturer to incorporate 18 separate and distinct improved features.

Louis Allis Motor.

The motors have been inspected and explosion tested by the United States Bureau of Mines laboratory and have also been tested and approved by the Underwriters' Laboratories, for use in all Class 1, Group D explosive atmospheres. Rugged, heavily reinforced cast-iron and steel construction with smooth streamline shape and double protected insulation, this motor is protected from every angle, it is stated.

Safety Valve

CONSOLIDATED SAFETY VALVE DIVISION

The Consolidated Safety Valve Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces completion of a new line of safety valves for elevated pressures and temperatures (2500 pounds at 1000°F.).

These new valves are to be installed on the highest pressure commercial steam boiler ever built in this country (over 2200 pounds W.S.P.).

Special alloy steels with low coefficients of expansion have been selected for the bodies, bonnets, springs and trim so that these valves will provide the same safe performance at this new high in operating conditions that is regularly produced in safety valves for 300 pound boilers. Bodies and bonnets are assembled with through bolts to prevent "freezing" at high temperatures. The trim of these valves is treated stainless steel. Constant seat diameter is insured by a new type of bevel seat in which the actual contact bearing between the seat and disc is always at the lowest portion of the seat surface. The single ring type of blowdown control is used. Note the thickness of the inlet flange, which is the new 2500 pound standard.

Low-Alloy Steel Rod

THE LINDE AIR PRODUCTS COMPANY

The Linde Air Products Company unit of Union Carbide & Carbon Corporation, New York, has announced a new low-alloy steel welding rod, Oxweld No. 32 C.M.S. Steel Welding Rod, for applications requiring welds of particularly high strength. It was developed primarily for insuring uniformly high-quality welds in high-strength steel pipe and plate welded by the Lindeweld process. This rod develops an average tensile strength of 10,000 to 12,000 pounds per square inch greater than rods previously used for pipe welding, yet has sufficient ductility to meet any requirements.

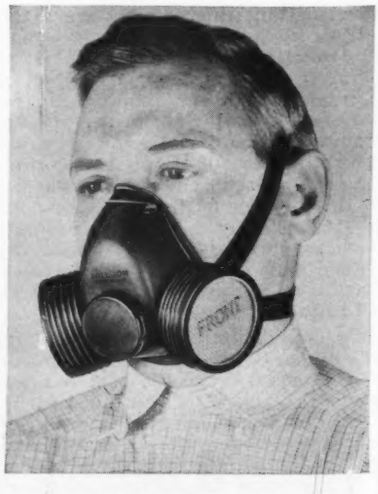
Another outstanding characteristic of this new rod is its exceptional resistance to overheating in the molten state. Because of this, the rod is particularly suitable for use with the new four- and six-flame tips which have recently been developed for Lindewelding pipe lines. When applying this rod, the weld metal sets up more rapidly, making it easier to control the puddle on a curved or vertical surface. This makes greater welding speeds possible and also effects a reduction in gas consumption per weld.

Respirator

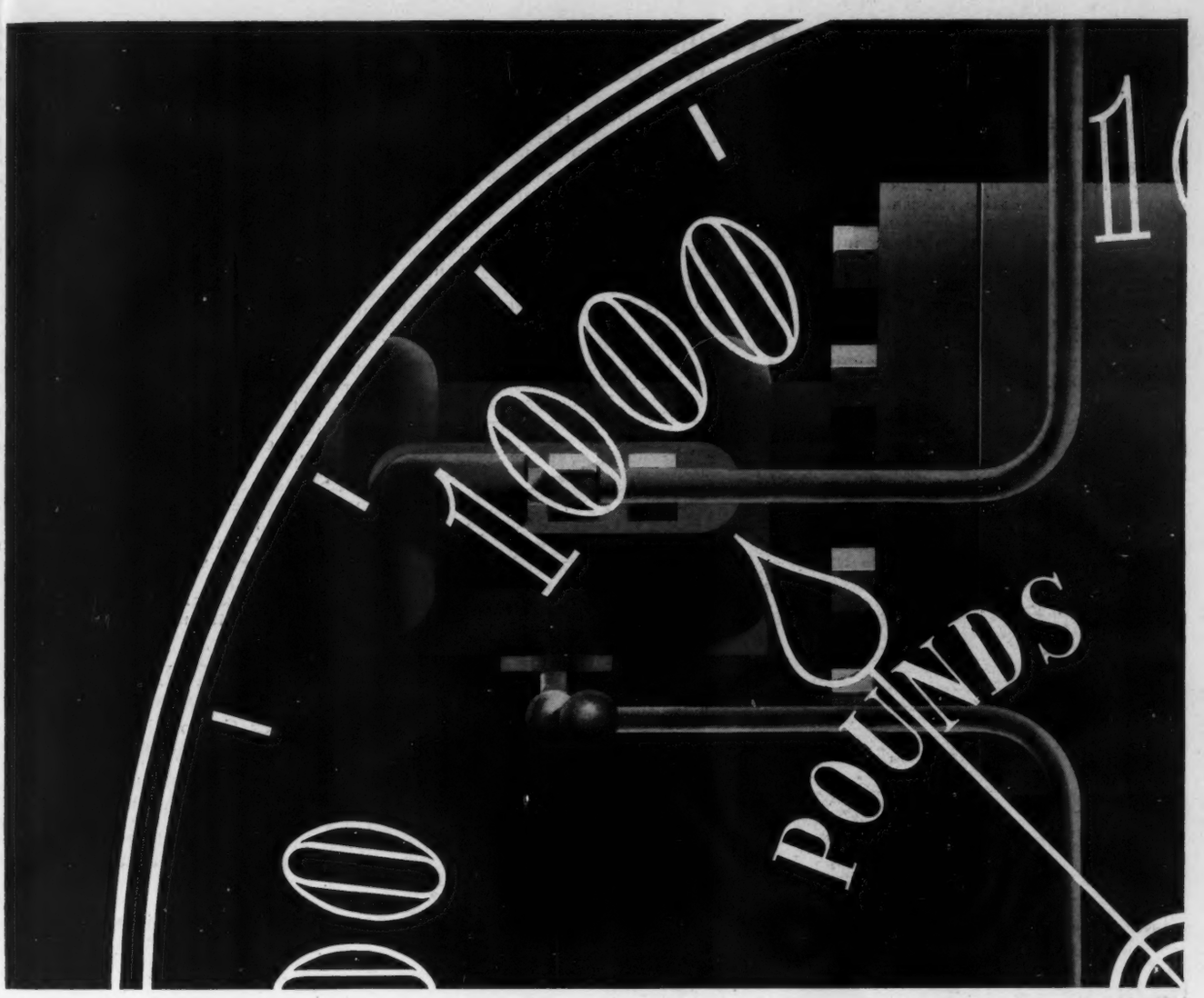
WILLSON PRODUCTS, INC.

Willson Products, Inc., 292 Thorn St., Reading, Pa., announce a new low-resistance chemical cartridge respirator especially designed for plating operations, brazing, paint spraying, etc., and for use in light concentrations of organic vapors and acid gases.

This new respirator, which is available in either 190 or 100 cc. content, has several distinctive features. It employs two inexpensive replaceable cart-



Willson Respirator



STOPPING TWO LEAKS WITH ONE PLUG

A builder of heavy-duty machine tools encountered a hard-to-solve problem in hydraulic chuck manifolds. Maintaining the 1000-pound pressure necessary for machine precision and efficiency was difficult because the porosity of the iron used permitted oil leaks. Production rejects were as much as 50%—and extra costly because the deficiencies were usually not discovered until after the cylinder had been machined and tested.

Doing one thing stopped two leaks: Adding 0.35% Moly to the iron eliminated porosity; and stopped wasteful production costs as well. It gave the cylinders the necessary strength for maintaining pressures continuously. It contributed to the operating efficiency of the machine.

There are scores of other instances in which Moly has definitely proved its capacity for improving the structure, strength and wearing qualities of cast iron. Our free book, ***"Molybdenum in Cast Iron,"*** contains further facts of interest to engineers and production executives. Free. Climax Molybdenum Company, 500 Fifth Ave., New York.

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ridges which results in a very low breathing resistance. The use of extra large cartridges affords on unusually large degree of protection.

The new form-fitting rubber face piece conforms to the face, out of the way, and permits better visibility. Spectacles or goggles may be worn with comfort and the entire respirator is so compact that it may be worn underneath a welders' helmet without interference.

Three separate chemical fills are available, depending upon the use to which the respirator is to be put. Under no consideration should this respirator be worn for protection against carbon monoxide or in an atmosphere deficient in oxygen.

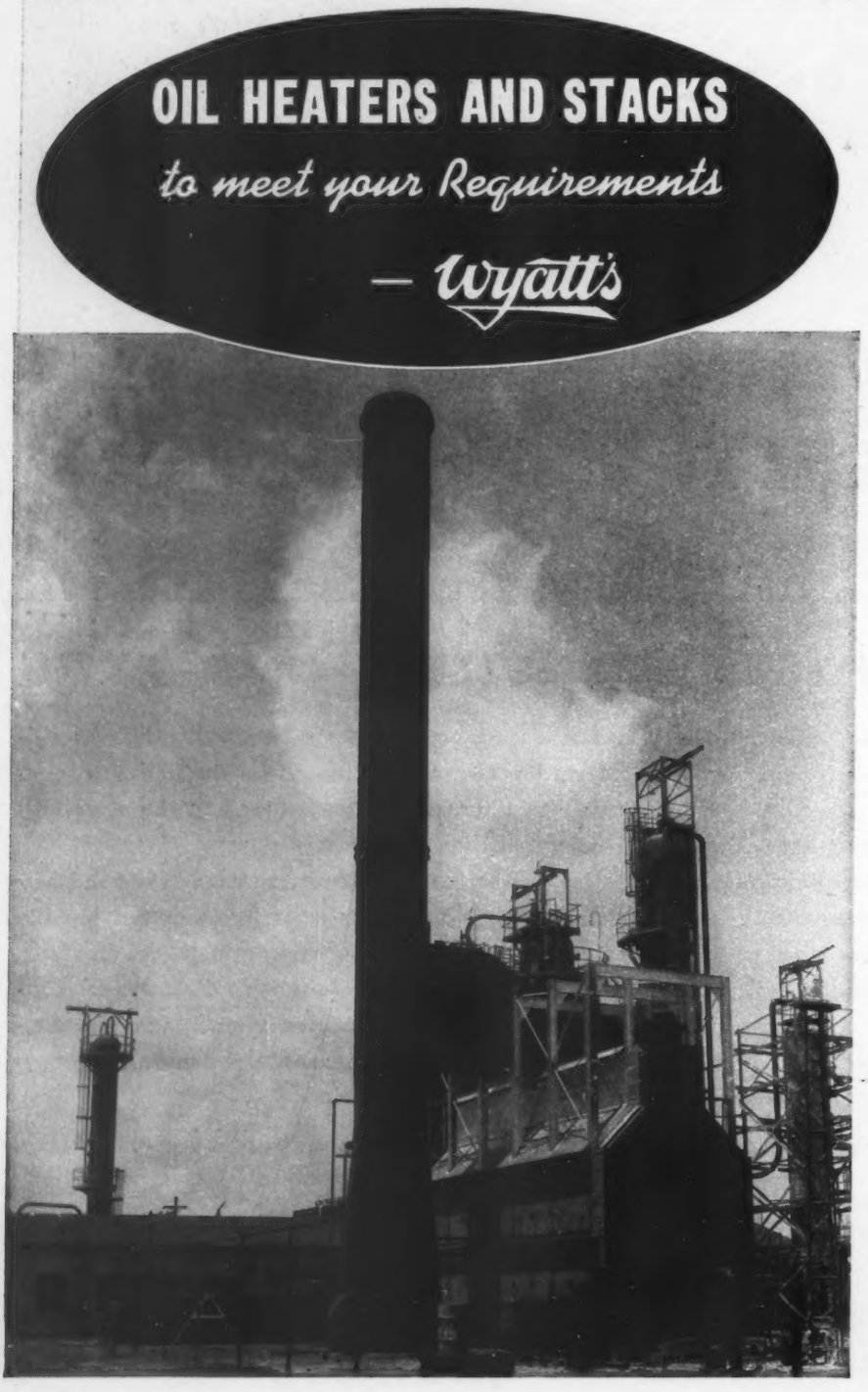
Eye Shield

JACKSON ELECTRODE HOLDER COMPANY

Jackson Electrode Holder Company, Detroit, Michigan, has developed a new shield for eye protection in connection with many industrial processes. This cover-all eye shield consists of a comfortable, light headgear, to which is attached an assembly consisting of a lens frame and two side protection members. The entire assembly can be pushed up, out of the way when not in use. The lens frame swivels to adjust the lens angle and provision is also made for the easy adjustment of the distance of the lens from the face. Standard Federal Specification lens are used, protected by cover glass. It is made in three types. One for torch work, gas cutting and general maintenance welding, has lens frame and side pieces of light opaque material, the frame fitting the face closely.

Another model, for the use of men working on gun, spot and flash welding, pouring metal and general grinding operations, has lens frame and side protection shields of transparent non-inflammable material, affording maximum vision. A third model is designed particularly for the use of gas welders on automobile body work and similar production operations and for gas welding inspectors and welders' helpers. The lens frame is cut away sufficiently on the under side to allow vision under the lens as well as through the lens, without adjusting the lens frame. This allows the wearer to walk around his work easily, pick up tools and so on, without danger of accident.

Advantages claimed for these shields include a wide vision, lightness, no irritation of nose bridge. The manufacturers assert that experience has shown that workmen willingly wear these shields in proper position, thus avoiding injuries that often result from the improper adjustment.



Resistoflex Tubing

RESISTOFLEX CORPORATION

Resistoflex Corporation, 370 Lexington Avenue, New York, announce the completion of facilities at its Dover, New Jersey, plant, for the manufacture of "Resistoflex" PVA Tubing in diameters up to and including ½-inch inside diameter. Facilities will be provided in the future for the production of larger sizes.

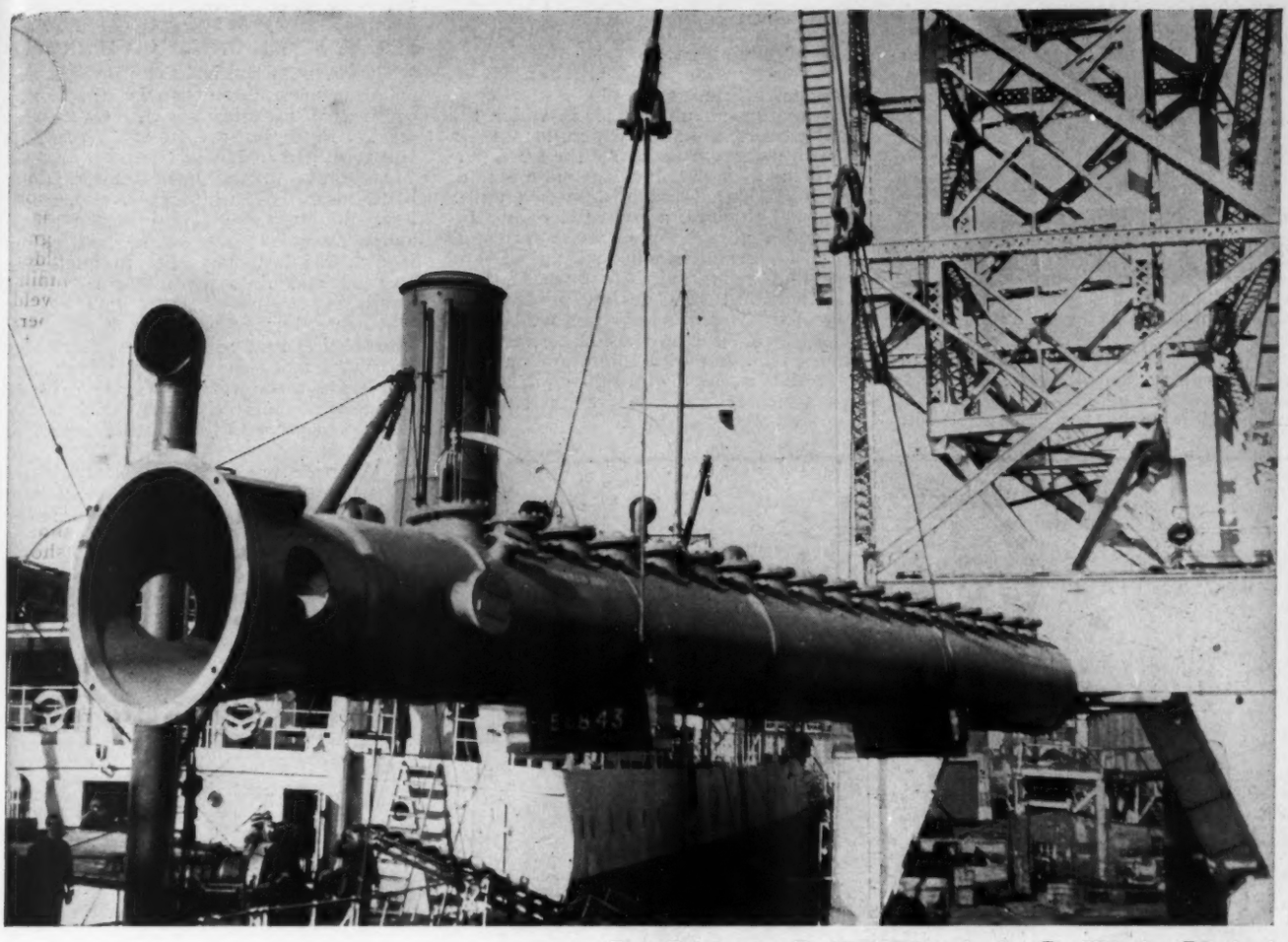
"Resistoflex" is the trade mark and trade name employed in the American production of a flexible synthetic resin —basically, polyvinyl alcohol—which is inert to gasoline, oils and organic solvents; which retains its flexibility throughout a wide temperature range, and which has been manufacturer, tested and sold on a commercial scale during the past several years by foreign corporations with which Resistoflex Corporation is indirectly affiliated.

This patented tubing is being used successfully abroad in many industrial applications: chiefly in the fuel and brake lines and lubrication systems of automotive equipment, Diesel engines and aircraft; in the conveying of solvents and minerals and vegetable oils in the chemical and process industries; in hydraulic lines; and in fuel and oil handling equipment.

The material, it is claimed, is the only commercially-known substance that is completely insoluble in gasoline, oil . . . the aliphatic compounds and aromatic series of hydrocarbons—ethers, esters, alcohols, ketones, etc.

Physical characteristics of "Resistoflex" include extreme lightness—the specific gravity is approximately 1.26, one-half that of aluminum; great toughness; a remarkable pressure-resistance; good elasticity; and a flexibility so marked that "Resistoflex" tubing literally may be tied in knots. It is highly efficient in absorbing vibration. Under normal conditions of use over a long period, it shows no trace of wear, fatigue or deterioration.

At present, "Resistoflex" is offered in the form of tubing in standard sizes,



MASSIVE CONSTRUCTION

PRODUCTS—

ASME & ASME-API Welded Vessels. Towers and Tanks, Riveted or Welded. Agitators. Absorbers. Condenser Boxes. Heat Exchangers. Pressure Vessels. Stills. Still Bottoms. Fabricated Plate Work. Special Machinery. Angle Bending. Any Special Equipment for Refineries.

FACILITIES—

X-ray Equipment. Stress Relieving Furnace for towers up to 17 feet diameter, any length. Metallurgical Laboratory. Tank Shop. Steel Shop. Foundry. Complete Machinery Plant. Complete service for building made-to-order equipment. All-welded or riveted vessels. Chrome-Nickel and Alloy Welding and Machining. Rail or Water Shipments.

The buyer of this massive piece of refinery equipment knows that in our plant is every facility to construct his equipment to the highest standards. The entire piece annealed at one time in the largest furnace in this country. Also tested by X-ray.

Pieces too large for rail clearance can be shipped by water. Above picture is a recent shipment direct from our plant.

SUN
SHIPBUILDING & DRY DOCK COMPANY
CHESTER, PA.

although "Resistoflex" gaskets, washers, packing, diaphragms and sheet material are scheduled for later production. Specially-designed couplings have been developed for use with "Resistoflex" tubing, each tube length with its couplings ordinarily being supplied as a unit.

New Sand Blast Gun

MICHIANA PRODUCTS CORPORATION

Michiana Products Corporation, Michigan City, Indiana, recently announced a new sand blast gun which incorporates features of design and principle said to provide better surfaces for painting and finishing wood and steel in much less time and without injury to the surfaces of the materials. Exclusive license agreement for the manufacture and sale of this gun has been made with Frederick W. Schultz, the inventor.

This gun has a chamber in which the sand meets a baffle which sets up a whirling motion reducing the sand particles and increasing the number of cutting edges. Sand is delivered under pressure through a flattened orifice fitted with abrasive-resistant alloy steel lips. The result is a flat stream of sand expelled under uniform pressure. It is claimed that this design permits the use of lower cost sand—removes grime, grease, and old finishes faster, and reduces buckling to a minimum on light materials without cutting or pitting the surfaces. Micro-photographs show a smooth, clean surface.

PRECISION THREADS

—on 1 to 2 inch pipe are obtained with a "TOLEDO" No. 1BR Ratchet Threader.

A separate set of dies for each size pipe, 2" dies are high speed steel, assures accurate, smooth standard taper threads, and easy operation.

No bushings are used. Three jaw pipe holder makes for easy, accurate centering. Minimum number of moving parts—long life.

Finest of materials and workmanship to give long, hard service.

Specify a "TOLEDO" No. 1BR and learn the difference.

The Toledo Pipe Threading Machine Co.

TOLEDO, OHIO NEW YORK OFFICE, 72 LAFAYETTE ST.

"TOLEDO"

Diesel Batteries

THE B. F. GOODRICH COMPANY

The B. F. Goodrich Company, Akron, Ohio, announces a complete line of specially constructed batteries for Diesel starting service. In the line are 4 6-volt types, 2 8-volt types and 10 12-volt types.

According to the manufacturer, these batteries are built with thinner plates than heavy-duty types, giving instant reaction and quick motor turnover. Adequate power is available instantaneously to ignite the fuel oil and start the motor in coldest weather.

All batteries, except the 8-volt types, are assembled in hard rubber cases. The 8-volt types are assembled in hard rubber jars and wood cases. Connectors are of solid lead, except the 8-volt types, which are of flexible copper with lead coating to prevent corrosion.

Cell covers are made of reinforced hard rubber, terminal posts are of the braced type, with rubber gasket seals and locknuts to prevent acid seepage, allowing for vibration of plates without causing damage. Splash-proof vents are used and ample sediment space provided to prevent battery failure as a result of short circuits arising from an accumulation of sediment touching the plates.

Oil and Water Extractor

SPRAY ENGINEERING COMPANY

Spray Engineering Company, 173 Central Street, Somerville, Massachusetts, has recently developed a new oil and water extractor which has been designed to keep compressed air lines free from oil and moisture. It has no moving parts or packing and requires no adjustments. An automatic drain valve prevents the accumulation of condensate in the reservoir at the bottom of the extractor shell.

Elimination of moisture and free oil is obtained by the cooling effect of a small volume of circulating water passing through a cooling coil, by a reduction in the air velocity through the extractor, and by changes in the direction of the air flow. Oil and water are collected on a series of baffles in the air stream, deposited in the reservoir and automatically drained off.

Spirotallic Gaskets

JOHNS-MANVILLE

Johns-Manville, 22 East 40th Street, New York, has developed a new type of gasket constructed of pre-formed plies of asbestos and cold-rolled, cadmium-plated steel for modern power plant equipment. Known as the "Spirotallic Gasket," it is for sealing boiler manholes, handholes and tube plates. The material is spirally wound in such a manner that the asbestos serves to seat the adjacent, interlocking metal plies. As soon as compression is encountered, the strong, rigid edges of the plies meet the bearing surfaces of the manhole, handhole or tube plate to form a series of metal barriers that provide a tight and effective seal against extreme pressures and high temperature conditions.

A feature of Spirotallic gaskets is their ability to compress under flange pressure and then to rebound when the pressure is removed. This resiliency is obtained largely by the central crimp of the interlocking plies, which provides a constant spring action that enables the gasket to compress and expand

ANOTHER ALCO DISTILLATION UNIT

This Time Socony-Vacuum Oil Company Adds a 7500 bbl Atmospheric Unit to its Paulsboro Refinery.

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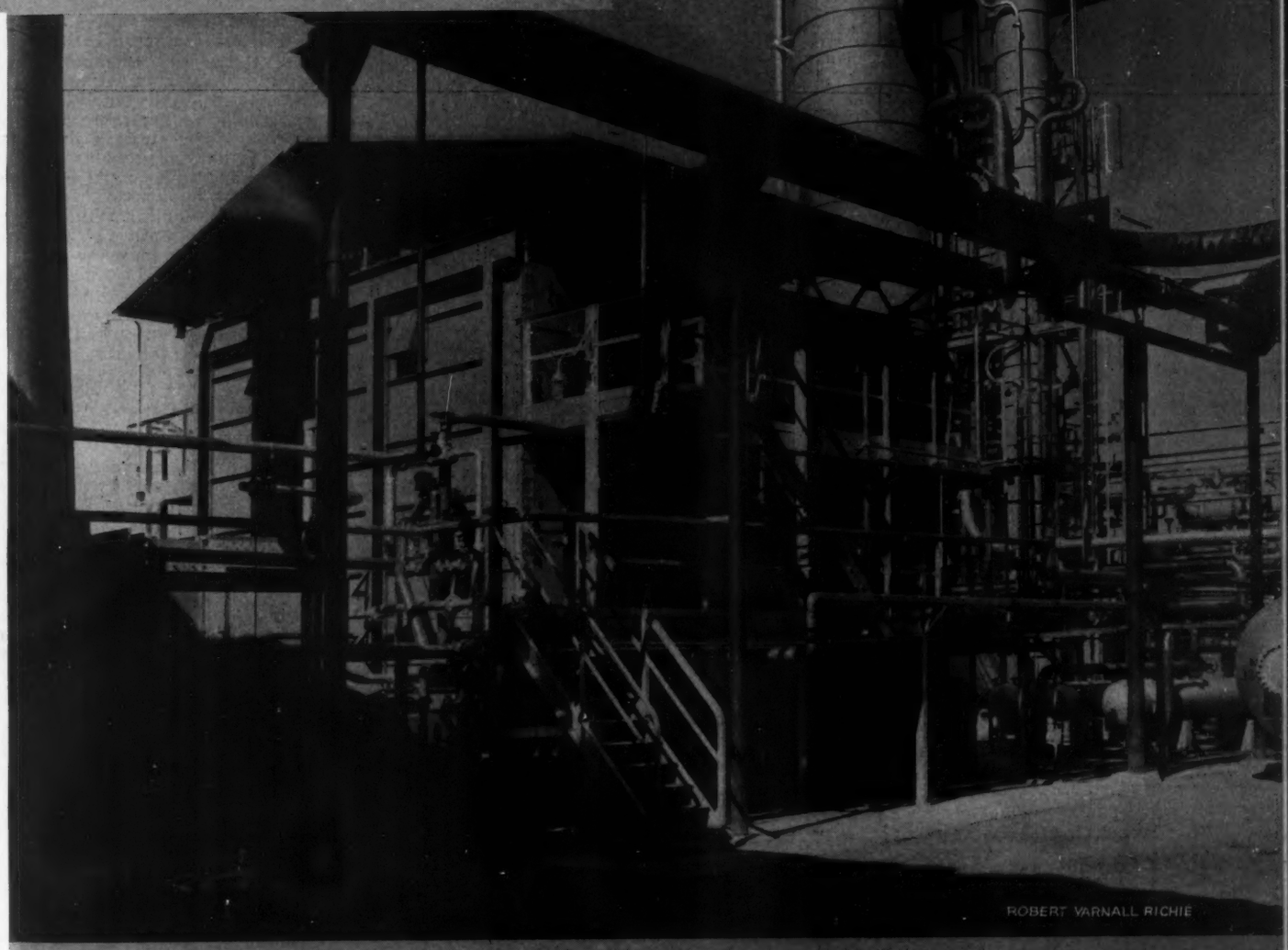

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automatically as the gasketing space varies in service.

Tests conducted on these gaskets in the Johns-Manville Research Laboratories, and under actual operating conditions, have shown them to be both durable and efficient, with the result that the problem of follow-up is reduced and long service with low maintenance is assured, it is claimed. Often it is possible to use the same gasket over again.

Spirotallic manhole and handhole gaskets are available in standard sizes in both round and oval form. The sizes of Spirotallic tube plate gaskets vary according to the boiler. This material is supplied in ⅛-, 3/16- and ¼-inch thicknesses. Special shapes of Spirotallic gaskets which are not standard can be manufactured on short notice.

Indoor Circuit Breakers

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announces that new indoor circuit breakers for both central station and industrial plant use are now available in ratings up to 15000 volts. Known as the Westinghouse type U De-ion air circuit breakers, these 2500 and 5000 volt breakers now complete a line of medium capacity indoor breakers with interrupting capacity ratings from 75,000 to 500,000 kv-a for 25 or 60 cycles or other commercial frequencies.

Type U De-ion air circuit breakers operate entirely without oil or liquid, function in normal atmosphere and are not dependent upon the maintenance of any medium such as air pressure or a vacuum. High speed arc control, arc resisting contacts, solenoid operation, universal mounting arrangements, improved mechanical construction assure low operating costs.

Low maintenance costs and inherent characteristics of the breakers have led to their use in highly repetitive services approaching contactor duty, such as reversing breakers for steel mill motors and primary breakers for steel mill motors and primary breakers for arc furnaces on voltages of 6600 and 13,800.

Gas Engine

WORTHINGTON PUMP AND MACHINERY CORPORATION

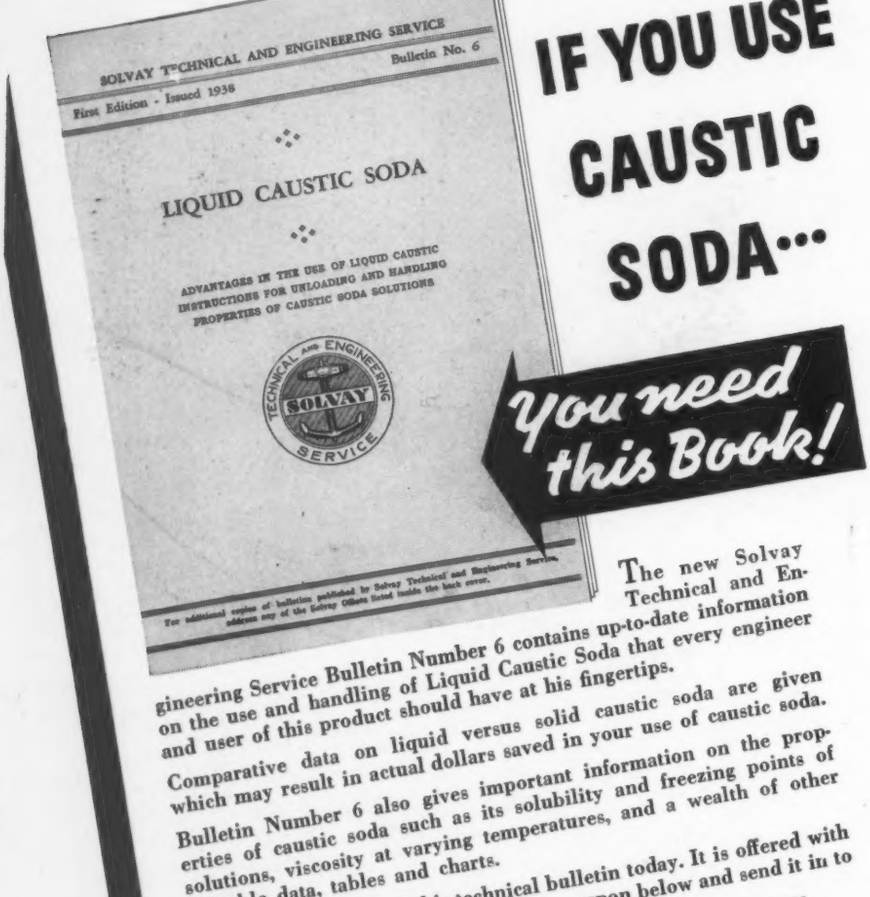
Worthington Pump and Machinery Corporation, Harrison, N. J., announces a new addition to the company's line of gas engines, which is designated as type LPE. It is of the vertical four-cycle design, a power unit arrangement of the company's LCE gas engine compressor unit. With the exception that frame extensions and running gear for the compressor cylinders have been omitted, the units are similar and all component parts are interchangeable between them. The LPE engine is of the multi-cylinder, trunk piston type with cylinders of the L-head design arranged in lines. The entire unit is totally enclosed and has full circulating pressure lubrication throughout. The straight line arrangement of cylinders provides easy accessibility and permits equal intervals between power impulses. This latter feature produces uniform turning effort and smooth operation with a very small flywheel. A single magneto can be used for all cylinders. The units are available in 4, 6 and 8-cylinder arrangements, conservatively rated at 180, 270 and 360 horsepower when running at 400 r.p.m.

Process Pumps

INGERSOLL-RAND COMPANY

Ingersoll-Rand Company, 11 Broadway, New York, announces a new series of refinery process pumps known as the Class FH and FL. Built in capacity to 800 g.p.m. and heads up to 400 feet, these pumps are designed for such refinery processes as those in which hot oils, distillates, bottoms, cold oils, propane, butane, solvents, etc., are handled. They will handle fluids at any temperature and are constructed for continuous operation on severe service, the manufacturer states.

The pump is supported by an extra heavy one-piece cradle which combines the connecting piece, the bearing housing and a water-jacketed reservoir. Its design is such that suction and discharge connections are integral with the casing. They open vertically and are therefore self-venting. Positive lubrication of the bearings is effected by rotary discs, the oil being contained in a large water-jacketed reservoir and circulated to secure thorough cooling. The stuffing box is likewise water-cooled, reducing heat transfer to the pump shaft and bearings. It is extra deep to receive a sealing cage if conditions warrant. Wearing rings on the impeller permit the renewal of worn parts with standard parts from stock.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BR-10

Electrode for Arc Welding

LINCOLN ELECTRIC COMPANY

The Lincoln Electric Company, Cleveland, Ohio, anounces a new electrode for construction of pressure vessels of high tensile steel.

The new electrode is designated "Fleetweld No. 9 HT" and has been developed for welding the new higher tensile steels of 70,000-80,000 pounds per square inch tensile strength which are gradually replacing steels of 55,000 pounds per square inch in pressure vessel construction.

In developing the new electrode, Lincoln engineers recognized the need for a rod suitable for welding deep-groove joints and capable of producing welds having higher tensile strength than those heretofore available in such work.

"Fleetweld No. 9 HT", produces weld metal which has extra strength and creep resistance at elevated temperatures. In addition to producing weld metal, possessing proper physical properties for high-pressure work, the electrode operates with alternating current or with direct current. Since it possesses good alternating current characteristics, it can be used with execellent results on either plus or minus direct current. It is for welding in a down, or flat, position only.

Physical properties of "Fleetweld No. 9 HT" weld deposits, stress relieved at 1200 degrees, are approximately as follows:

Tensile strength, lbs./sq. in.—70,000-76,000; Yield point, lbs./sq. in.—58,000-63,000; Ductility, % elongation in 2 in. —27-32.

Special features of the electrode include low splatter loss, high deposition rate, easily removable slag formation, well-shaped beads and weld deposits having minimum porosity.

"Fleetweld No. 9 HT" is made in 18-inch lengths in two sizes 3/16-inch and ¼-inch.

Arc Welder

THE HARNISCHFEGER CORPORATION

Harnischfeger Corporation, Milwaukee, Wisconsin, announces the new P&H-Hansen 200-ampere "Special" engine-driven welder. Built in answer to the demand for an engine-driven welder with a somewhat wider operating range than the average 150-ampere unit, yet much lower in price than the standard 200-ampere unit, the P&H 200-ampere "Special" represents one of the hugest bargains in the welding machine field at the present time, the announcement states. Consisting of a 200-ampere, commercial rated 30-volt 6 kw. generator with an intermittent welding range of 35 amperes to a maximum of 225 amperes, the "Special's" generator is connected by a flexible coupling to a 24-horsepower, 4-cylinder, water-cooled gasoline engine. The engine is equipped for hand-starting and with magneto ignition system. Its full tank capacity is 13 gallons, crankcase holds 3½ quarts of oil, and the cooling system contains 3¾ gallons of water. The entire unit is mounted on a formed steel base and equipped with a fully enclosing sheet metal canopy having removable sides for easy access to all parts. Although in its standard form the "Special" is a stationary type machine, it can be supplied with wheels. The "Special" is built to handle electrodes up to 7/32-inch in diameter under continuous manual operation. Equipped with a Continental motor of the type used on agricultural equipment, it is easily serviced.

Sheet Packing

THE B. F. GOODRICH COMPANY

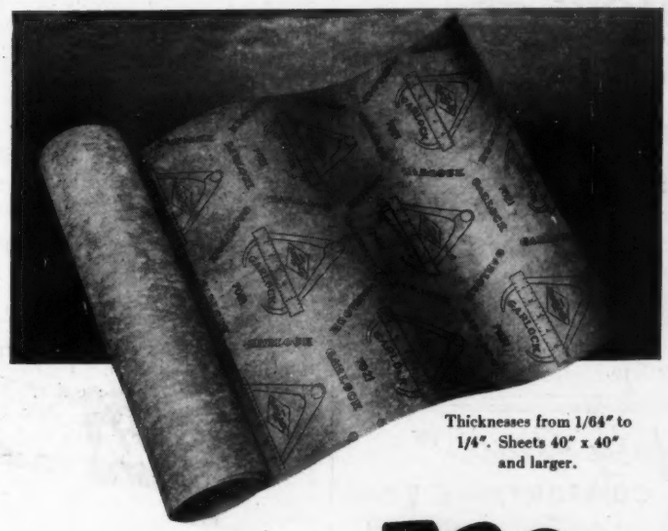
The B. F. Goodrich Company, Akron, Ohio, has announced a new addition to its line of compressed asbestos sheet packing which is known as Type 72. Black in color with graphite mixed throughout, this new packing is recommended for temperatures above 212° F. where gaskets are in contact with oil or solvent vapors.

Tank Vent

LION MANUFACTURING CORPORATION

Lion Manufacturing Corporation, Chicago, announce a new type tank vent which is said to employ a patented liquid seal principle which eliminates all mechanical parts, which is marketed under the trade name of "Econovent." The vent is designed for use on storage tanks containing gasoline, naphtha or other volatile liquids, and according to the manufacturers, reduces existing evaporation losses 50 to 75 percent.

As the storage-tank is filled, air escapes up through the center pipe, down through the left-hand pipe, and is



Thicknesses from 1/64" to 1/4". Sheets 40" x 40" and larger.

Garlock 7021

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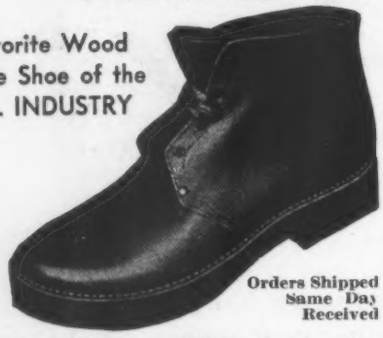

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forced through the liquid seal and out into the atmosphere through a screened vent in the right hand pipe.

When, on the other hand, gasoline or other fluid in storage is withdrawn from the tank, the liquid seal is raised by suction, through the left-hand pipe, into the upper chamber, creating a partial vacuum in the tank. Then, when a rise in temperature causes expansion, pressure equalizes the vacuum, and liquid seal drops to lower chamber—thus taking care of expansion without releasing vapors from the seal.

It is said that the liquid seal, operating as described above, takes care of all conditions as they occur, thus eliminating any build-up of pressure prior to a "pop-off." The manufacturers claim that "Econo-vent" greatly reduces evaporation loss, eliminates fire hazard, retains original gravity of gasoline or other liquid in storage, prevents moisture, dirt or dust from entering the tank, provides positive protection against damage due to excessive pressure, and eliminates all vent inspection and maintenance expense.

Dry Type Air Filter

STAYNEW FILTER CORPORATION

Staynew Filter Corporation, Rochester, New York, recently announced a new dry type air filter. The filter, known as the Wire-Klad, has, among others, the desirable feature of flame-resistance—fulfilling the provisions set forth in Section 150 of the National Board of Fire Underwriters, Pamphlet No. 90. Thus its installation is practical in many instances where fire hazard might otherwise exist.

The descriptive name, Wire-Klad, refers to the wire mesh reinforcement of the fins. The fin construction affords large filtering area in relatively small space. The wire mesh reinforces the filtering medium so strongly that the filter can be cleaned indefinitely by high pressure air or vacuum.

Several kinds of filtering media to suit varying conditions are available. The most usual are cotton or a wool felt-like material known as Feltex. This latter medium is practically impervious to the passage of even microscopic dust particles, yet offers extremely low resistance to air flow.

Economy is an important point in favor of this new air filter, it is said. Although the highest grade materials and workmanship are used throughout, the initial cost is low, due to careful design and the ingenious use of wire mesh. As previously mentioned, cleaning is practical and simple with either air pressure or vacuum.

If exposure to oil or greasy substances makes cleaning with a solvent necessary, the wire reinforced filter insert can be easily lifted from the frame. Besides low initial cost and easy cleaning, this new filter also possesses the advantage of low replacement cost when finally worn out, as wire reinforced filter insert only need be replaced.

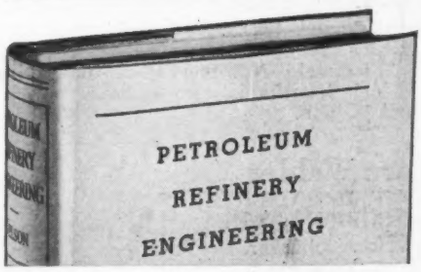
Standard and special sizes are available. There are three standard depths—2, 4, and 6 inches, and four standard sizes—20 x 20 inches, 16 x 20 inches, 16 x 25 inches and 20 x 25 inches. With the thought in mind that many installations require special sizes, these will be furnished at no extra cost if within reasonable limits.

Electric Arc Welder

OWEN-DYNETO CORPORATION

Owen-Dyneto Corporation, Syracuse, New York, has recently placed on the market a new alternating current welding machine known as the "USL Protected Arc AC Welder." It is designed to connect to any standard voltage or frequency power line. It is rated at 150 amperes and has a range from 30 amperes to 280 amperes output. Open circuit voltage of 55 volts maintaining 20 volts to 30 volts across the arc.

The arc welder is constructed in various details so as to speed up the welding process. It accommodates any commercial kind of AC welding rod. It is built to give thorough penetration for heavy work, yet it can be cut down to lower heat requirements for welding thin sheets. A steady arc is secured by means of a reactor on the secondary winding of the transformer. This stabilizer creates a power influx where the cycle passes the zero point. The arc is therefore constantly maintained and results in faster, easier welding with noticeably less spatter loss. Simplicity of control is emphasized by the single dial which permits of setting the machine to the requirements of the work at the beginning and operating it without further attention. The use of jacks or plugs to secure change of current is avoided. It is free from relays and magnetic switches, and has no moving parts whatever. In appearance the new unit is very compact. Its case has crackle finish in black. Two stout handles and four large casters make it easy to move. The total weight is 190 pounds.



Petroleum Refinery Engineering

By W. L. NELSON

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647 pages, 6 x 9, 185 illustrations

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A guidebook for plant managers, superintendents, chemists, engineers, and other refinery men. Provides a complete engineering treatment of petroleum processing, emphasizing its relation to chemical engineering. Covers fundamentals, many details of the design and operation of petroleum equipment, economical aspects, etc. Includes illustrations or examples of almost all important calculations.

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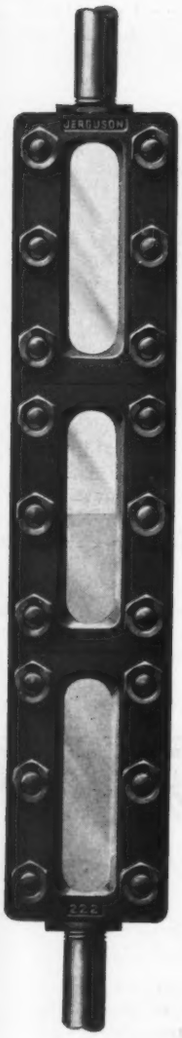

Jerguson Reflex and Transparent (thru vision) Gages have been noted for over 30 years for accuracy and dependability.

Reflex Gages indicate the liquid level, no matter what the color of the liquid. Ideal for tanks, towers, stills, etc., because the—

Empty space shows

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Liquid level appears

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Jerguson Transparent (thru vision) Gages for showing color and density of liquids, are also noted for their accuracy and dependence.

Jerguson Gages are best by every real test

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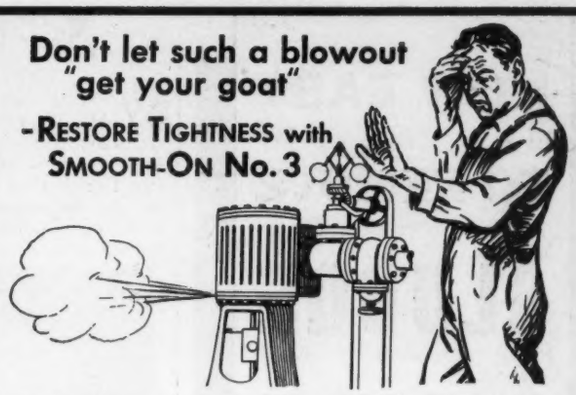


WHY take this cylinder down and put in a new gasket when *an equally dependable* seal can be made by removing the closest bolt, plugging the bolt hole of one flange with a wooden plug, filling the other with Smooth-On No. 3, forcing the Smooth-On into the leak with a rod and hammer (Fig. 1), and then replacing the bolt. The next bolt may be treated similarly if necessary. If studs are used in the flange, the reversed stud may be substituted for the wooden plug (Fig. 2) and the same method used, or a stud with hole in the center and outlet holes at the packing line (Fig. 3) may be used; also a grease gun with threaded connection to the drilled stud may be used to force in the Smooth-On.

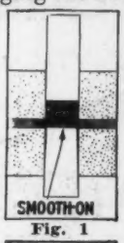


Fig. 1

Fig. 2

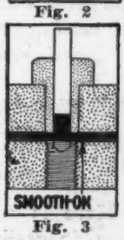


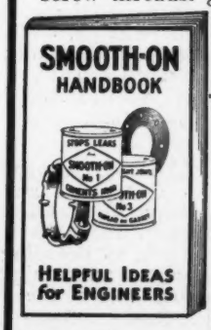
Fig. 3

This is but one of hundreds of the intensely practical time, money and labor saving power-plant repairs that can be made with Smooth-On. Be ready for any of them by getting a copy of the Smooth-On Handbook and having small cans of Smooth-On No. 3 and Smooth-On No. 1 in your store room.

Get Smooth-On in 1 or 5-lb. cans or larger keg from your supply house or if necessary direct from us.

Mail coupon for this FREE booklet

Contains instructions and diagrams for making loose parts tight and preventing or stopping leaks at screw threads. gaskets, seams, rivets, cracks, porous spots, etc. Every Engineer should have this useful repair information on his desk.



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MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

▼ BUSINESS NOTES ▼

WYATT Metal & Boiler Works, Houston and Dallas, Texas, announces the election recently of Raleigh Hortenstine as president, following the death of W. J. Wyatt, founder of the company and president at the time of his death.

RALEIGH HORTENSTINE
President, Wyatt Metal & Boiler Works

Since 1923, Hortenstine has been vice president and general manager and a director of the company. Prior to his joining Wyatt Metal & Boiler Works he gained much experience in the manufacturing and construction business, beginning with Penn Bridge Company as designing and construction engineer, during which time he was located in Pennsylvania, Washington, Louisiana and Texas. For a time he served Virginia Bridge & Iron Company as contracting engineer in charge of work in the Southwest and as plant manager at Memphis, Tennessee. He came to the Wyatt organization in an executive capacity in 1923.

Born in Washington County, Virginia, Hortenstine was graduated from Virginia Polytechnic Institute with the degree of bachelor of science in civil engineering, and did a year's graduate work in the College of Civil Engineering at Cornell University. He is a member of the American Society of Civil Engineers.

PERCO Incorporated of Bartlesville, Oklahoma announces the appointment of Process Management Company, Inc., 120 East 41st Street, New York, as licensing agent for the Perco copper sweetening process in the territory east of the Mississippi.

Perco copper sweetening has been adopted rather extensively in the Middle West where some 70 installations have replaced older type sweetening processes. These installations operate on a wide diversity of stocks, including natural, straight-run, cracked, vapor-recovery and polymer gasolines.

Process Management Company has been active for a period of years in licensing processes in the petroleum field.

DR. E. R. WEIDLEIN, director of Mellon Institute, Pittsburgh, has announced establishment of an industrial fellowship on meter technology by Pittsburgh Equitable Meter Company. Among the first projects to be investigated are the adaptation of synthetic plastics as constructional material for liquid meters and the development of a satisfactory substitute for the present leather diaphragms in gas meters.

Dr. R. L. Wakeman is to be the incumbent of this fellowship. He was trained at Massachusetts Institute of Technology, from which institution he received the degree of Ph.D. in 1930. After two years of post-doctorate study at Paris and Zurich he held a position in industry until he joined the research staff of the institute in 1935. Dr. Wakeman in addition to his broad training and experience in various fields of chemistry, is an authority on synthetic resins and plastics.

In commenting on the meter fellowship, Colonel W. R. Rockwell, president of Pittsburgh Equitable Meter Company, stated: "It can be safely said that a very great part of the rapid progress in industry of today has been the result of the close link between science and technology. Our company owes its existence to the pioneer work of its founders, including such men as George Westinghouse and Fred Holdship. Horace Chrisman, who has been with us for over 50 years, worked directly with Westinghouse and at pres-

DR. R. L. WAKEMAN
Industrial Fellow Meter Fellowship, Mellon Institute, Pittsburgh

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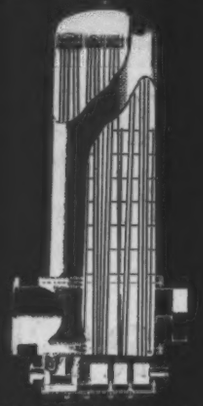

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"Newark" makes more than 3000 varieties of Wire Cloth, all Grades and Metals, Heavy to Extra Fine; Filter Cloths (Metallic); Gasketed Filter Cloth; Centrifugal Cloths; Laboratory Testing Sieves, A.S.T.M., U. S., and all other recognized standards; Removable Bottom Strainers; Foundry Riddles; Sand and Coal Screens; Bolting Cloth; Dutch Cloth; End-Shak Sieve Test Machines; Stainless Steel, Monel Metal, "Nichrome" Cloths; and Fabricated Wire Cloth Parts to Customers' specifications.

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ent has a number of new meter developments ready for application. We have always maintained and will continue to maintain completely equipped and staffed chemical and physical laboratories which are constantly searching for better metering methods and materials. The scientific and technological problems involved in producing something better sometimes require intense research by scientists who can devote their entire time and energy to solution in a manner which cannot be expected from laboratories dealing with daily practical problems."

KAYE & MacDonald, INC., West Orange, New Jersey, announces appointment of two new distributors in Texas and Oklahoma. The Moorlane Company, Tulsa, has been appointed stocking distributor for the K-Master modernized inverted steam trap for Oklahoma and Kansas.In the Houston territory, Joe E. Young, 402 Hyde Park Boulevard, has been appointed stocking distributor, handling the same steam trap. He will cover the coastal district of Texas. The K-Master trap is so designed that working parts are outside of the case and is provided with reversible valve and seat.

PLASTICS DIVISION, Monsanto Chemical Company, Indian Orchard, Mass., has announced the establishment of a St. Louis district sales and technical assistance office. The office is in the Monsanto Building, 1700 South Second Street, St. Louis. Joseph E. Gee, formerly of the Chicago staff, is in charge.

J. W. MERIAM, for the past 24 years vice president and secretary of the Lincoln Electric company, has retired at the age of 60, but will remain as a director of the company. He joined the company in 1914 when arc welding was still in the experimental stage and his retirement closes a business career which spans the growth and development of the arc-welding industry. The company's credits and collections are to be handled by Frank K. Greisinger. A. F. Davis, vice president, was elected secretary.

JASPER H. FISHER

C. S. QUILLEN, Ch. E., has been placed in charge of field engineering for Mixing Equipment Company of Rochester, New York, in New York City and Central Southern territories. For the past several months he has been assisting with development work at the Rochester plant. A graduate of Drexel Institute, Quillen was formerly with Alco Products, and Carbide and Carbon Chemical Corporation. Quillen will maintain headquarters at 377 Broadway, the New York office of Mixing Equipment Company.

J. A. CAMPBELL COMPANY, development and manufacturing engineers, Long Beach, California, announces the appointment of Lloyd E. Eyre, as Texas representative. Eyre is making headquarters at Houston (Box 727). Eyre will work with refiners and gasoline manufacturers in the state in the sale and servicing of the Campbell cantilever boiler feed water controller, the Campbell Mist-D-Fier scrubber and other equipment items.

JASPER H. FISHER, who for more than 25 years has been the active head of Fisher Governor Company, passed away recently in St. Josephs Hospital at Orange, California, where he had been a patient since the first of last April. Funeral services were held at St. Pauls Episcopal Church, Marshalltown, Iowa. He is survived by Mrs. Fisher and their four children, Mrs. R. L. O'Toole, Martha Ellen Fisher, Allan and J. William Fisher. He was born in Marshalltown on September 6, 1878, the son of Mr. and Mrs. William Fisher, the founder of Fisher Governor Company. He was educated in the public schools of Marshalltown and attended Iowa State College at Ames. Following that, he spent a number of years in sales work before becoming associated with Fisher Governor Company, which he was later to build into one of the largest manufacturing concerns of its kind in the country. The organization at the time he joined it consisted of only 14 people, and today includes approximately 300.

When he became associated with his father's manufacturing business, the company was making only two or three types of automatic controls. Today it is producing more than 157 separate and distinct types of various controls such as pump governors, liquid level controllers, automatic pressure regulators, gas pressure controls, steam traps, etc. Mr. Fisher was especially well known in the petroleum industry.

FOR SALE

1 Stephens Improved Consistometer with Transmission and Journal Attachments No. 503, good condition, priced at a substantial saving. For further details, write V. LeMay, Dan Waggoner Bldg., Fort Worth, Texas.

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Quit Wasting Time and Money on Pipe Wrench Repairs

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Millions of RIDGID wrenches in use under that housing guarantee — and the users will tell you they *stay on the job!* That proves how RIDGIDs help you avoid the nuisance of repairs, let you get along with fewer wrenches, save you money.

You enjoy using the safe all-alloy RIDGID with its replaceable chrome molybdenum jaws, its adjusting nut that never binds even in the 60″ size, its powerful I-beam comfort-grip handle.

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New All-Steel and Malleable Alloy RIDGID Threader

Better, easier, faster pipe threading, threads 4 sizes of pipe with 1 set of chaser dies — choice of two speedy new automatic workholders. Write for new folder.

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How TO KEEP THEM HOT ALL THE TIME . .

Do you know why your unit heaters are lukewarm? Why they run first hot, then cold? The chances are 9 times out of 10 that your trouble is the presence of condensate and entrained air in the unit. You can keep your units hot all the time, delivering their full rated capacity regardless of conditions by replacing those temperature actuated traps with positive acting Anderson Super-Silvertop inverted bucket traps. In actual tests 25% more heat was delivered by unit heaters after Anderson Super-Silvertops replaced inefficient traps.

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Find out how to keep your unit heaters at top efficiency all the time—send for data showing how to get more heat from your present units—it may save you money!

THE V. D. ANDERSON CO.
1942 WEST 96th STREET • CLEVELAND, OHIO

Gentlemen: Please send me any data you have that will help me get more heat from my unit heaters.

Name..... Address.....

City..... State.....

CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Steam Trap

Kaye & MacDonald, Inc., West Orange, N. J., has published a new engineering type of catalog on steam traps and trapping problems. The company manufactures the K-Master modernized inverted bucket steam trap which has incorporated several unusual features in steam-trap design. The catalog is well illustrated with line drawings and photographs and contains much engineering information of value to those interested in steam-trap construction, operation and maintenance.

Laboratory Apparatus

Industrial Scientific Supply Company, Fort Worth and Houston, Texas, is distributing its new 90-page catalog No. 3,000, covering Laboratory Apparatus with particular reference to equipment used in refineries, natural gasoline plants and other industrial plants. The catalog is fully illustrated and lists latest equipment for laboratories, as well as the new "Gold-Back" Taylor Instrument Company thermometers.

Plastic Fire Brick

Laclede-Christy Clay Products Company, St. Louis, Mo., has published a new catalog covering Laclede Furnaseal plastic fire brick and Laclede super plastic. Several features with regard to monolithic furnace linings, anchorage data and detailed engineering department specifications are of interest and value.

Flow Control

The Foxboro Company, Foxboro, Mass., has published Bulletin No. 170-1, a new 38-page catalog which contains an unusual amount of application data on instruments for control of flow in industrial processes such as controlling hot and cold oil, gas, molten sulfur, air, acids, caustics, gasoline, steam and chemical solutions. Among typical examples of flow control are liquid flow, gas volume, flow control of geared pumps, of turbine-driven centrifugal pumps, of crank and flywheel pumps, of gas engine-driven reciprocating pumps, multiple drive pump control and split feed control. Schematic diagrams accompany each discussion. Flow control accessories are given, together with chart ranges. A section devoted to piping layouts and flow control mounting contains much useful information for the installation of various flow controllers.

Refractory

Laclede-Christy Clay Products Company, St. Louis, Mo., has published new literature describing its new Laclede Periac Diaspore refractory which combines the high refractoriness of the Diaspore clay with the extreme spalling resistance of the super-duty fire clay brick. The material is non-spalling, non-shrinking, slag resisting, power pressed refractory designed for use where very high temperatures, combined with sudden temperature fluctuations, heavy loads, or the action of destructive slags is present.

Trucks and Casters

The Fairbanks Company, 20 East 4th Street, New York, has published two new highly illustrated catalogs. Catalog No. 52, 48 pages, is devoted to describing "Fairbanks Platform and Special Trucks," and Catalog No. 53, with 24 pages, deals with "Fairbanks Truck Casters and Wheels."

Copper Alloys

Revere Copper and Brass, Incorporated, 230 Park Avenue, New York, is offering for distribution a technical and engineering discussion "Copper and Copper Alloys," by M. G. Steele, technical adviser for the company's Baltimore Division. This technical article gives helpful and accurate information to all those interested in copper and its alloys and their industrial or process applications. The composition chart accompanying the reprints is of especial interest for 30 copper alloys are listed, their composition presented, their physical properties and uses and methods of working.

Suspended Walls

Bigelow-Liptak Corporation, Detroit, Michigan, has published a new bulletin on Unit-Suspended Walls, explaining the reasons why these furnace walls are claimed to secure minimum maintenance, conduction losses and air-infiltration. It is designed to be an engineering story rather than a catalog.

Controller

The Brown Instrument Company, Philadelphia, Pa., has published Bulletin No. 89-9 on Brown Air-Operated Controllers in which the adaptability of the controllers to the varied control requirements of industrial processes is demonstrated in a representative list of 50 applications. Several installations are illustrated.

Flooring

Kerlow Steel Flooring Company, Jersey City, New Jersey, has issued a new catalog covering Kerlow Steel Flooring, Bridge Paving and Steelej Armor which is profusely illustrated and contains all technical and engineering data relative to the above subjects.

Rubber Goods

Goodyear Tire & Rubber Company, Akron, Ohio, has published a new illustrated catalog of mechanical goods products manufactured by this company and is of interest to all users of mechanical rubber goods. In addition to information on construction and application of various mechanical goods, the catalog also contains valuable hints on proper care of rubber belting and maintenance of belting service records, and complete list of Goodyear mechanical goods branches throughout the United States.

Cleaning Materials

Oakite Products Company, Inc., 14 Thames Street, New York, has published a new booklet fully describing the latest methods for handling the many necessary cleaning operations in connection with truck motor repairing and fleet maintenance.

Fleet operators wishing to avoid fire hazards in their cleaning work will find particularly helpful the detailed data on the use of effective, safe, water-soluble materials in such operations as washing motor interiors and exteriors, steam or tank cleaning engine repair parts, paint-stripping by the cold solution or hot flow-on methods, and general plant maintenance cleaning. Radiator cleaning and truck body and chassis washing are also fully explained.

Surface Condensers

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued a 24-page illustrated booklet describing radial flow surface condensers designed to assure highest heat transfer efficiency. The basic principles, construction and operation are studied in this booklet. Auxiliaries, such as circulating and condensate pumps, steam jet ejectors, atmospheric relief valves, expansion joints, steam and electric pump drives, which assure additional efficiency and reliability, are also discussed.

Three types of pumps described and illustrated are the impeller type, suitable for all condenser applications, but primarily used where a high section lift or high pumping head is specified; the propeller type, suitable where a moderate or large quantity of water at a relatively low pumping head is required; the axial type pump, for installation requiring a moderate pumping head and suction lift.

Charts useful for calculating size of condenser and amount of circulating water required for a given duty, and also for approximating the performance of a given condenser with ¾-, ⅞-, or 1-inch O.D. tubes are shown.

Gas Masks

Acme Protection Equipment Company, 3616 Liberty Avenue, Pittsburgh, Pa., has issued Folder M-387, which is new descriptive literature covering the officially approved full-vision gas masks made by this company. The folder is fully illustrated and all pertinent information on full-vision masks is presented.

Transformer

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has published Bulletin 43-131 on its Type PV-130 portable voltage transformers designed for use with Westinghouse portable instruments and recorders. These transformers are obtainable with primary voltages from 230 to 6900 volts and with accuracy with plus or minus one fourth percent.

Vacuum Cooling

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued Bulletin F-8445 covering vacuum cooling apparatus which is adaptable for either continuous or batch cooling within a range of 35 to 65°F. The steam jet units meet a wide range of applications and processes requiring a combination of cooling action and evaporation, degasifying or crystallizing action.

Process Control

The Bristol Company, Waterbury, Conn., has published Bulletin No. 511, describing installations using Bristol's System of Coordinated Process Control. A few outstanding features about the operating results of each application are given.

Check Valves

Crane Company, 836 South Michigan Ave., Chicago, has published "Checking Up on Check Valves," an eight-page, two-color booklet which covers the check valve field in text, pictures and diagrams. The two basic types of check valves are described, their various applications are discussed, ten "Do's and Dont's" are listed and two pages are devoted to cross-section views in what is termed a "Handy Reference Guide to Crane Check Valves."

Bulletin Boards

Mine Safety Appliances Company, Pittsburgh, Pa., has just issued a new informative bulletin describing its specially designed bulletin boards for safety and general bulletins. These bulletin boards are used extensively by both large and small companies for supplementing safety and educational programmes. They are sturdily built of 24 gauge steel, finished in green enamel and are available in either single or double board types.

Diesels

Worthington Pump & Machinery Corporation, Harrison, N. J., has published Bulletin S-500-B35 describing its latest type BB line of vertical direct-injection Diesel engines. Developed for installation where continuous heavy-duty loads are carried, these machines are also peak-load units for larger plants having other types of prime movers. Complete specifications, together with an interesting sectional view describing in detail the important features of design, are contained in the bulletin.

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